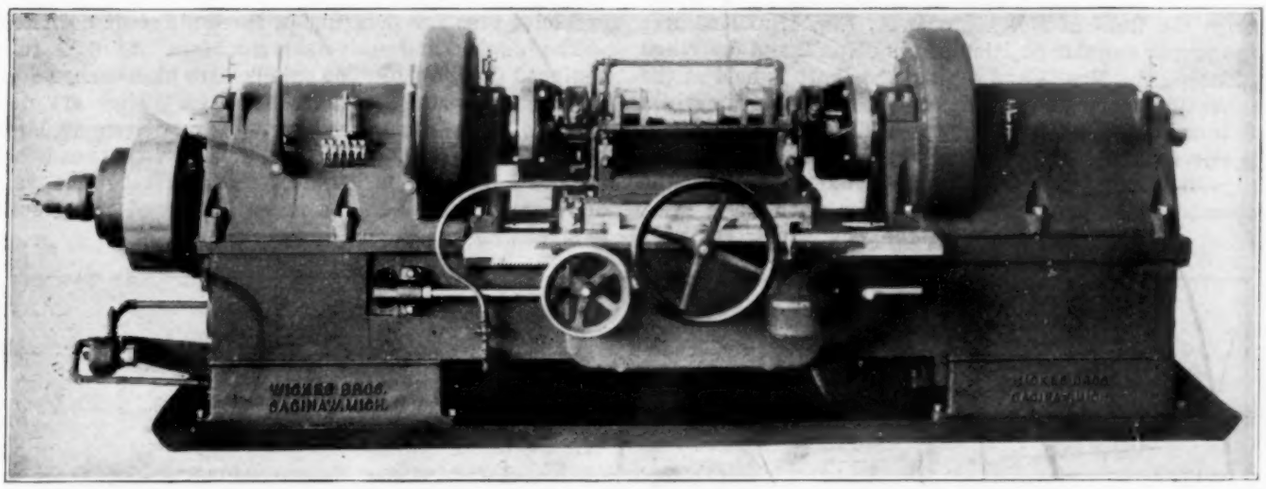
January 8, 1920 American Machinist Vol. 52, No. 2



The Wickes Crankshaft Lathes

By J. V. HUNTER
Western Editor, *American Machinist*

Manufacturers of machine tools are vieing with each other in bringing out tools for increasing production, especially in the automotive field. In this article two tools designed for the high production of crankshafts are described and also illustrated.

A LATE addition to the many high-production machines being put on the market is a crankshaft lathe built by Wickes Bros., Saginaw, Mich. It is the purpose of this machine to expedite the work of turning crankshafts, whether they have one or a dozen throws. However, it goes further than this and can be readily adapted to facing off the cheeks of the webs. The machine is built in two standard types — one known as the "Duplex" for turning two pins simultaneously, and the other, the "Universal," for turning only one pin at a time. The advantage of the universal over the duplex machine exists only when the production requires 60 or less crankshafts per day, this representing its average daily capacity on six-throw crankshafts. For greater capacity it is advisable to use the duplex machine and install a sufficient number to care for the production requirements of the plant. As machines of this type are tooled for turning two specific pins it is advisable to install them either in units of two for a four-throw crankshaft, or three for a six-throw shaft. Aside from the pot-chucks and the tooling, these two machines are practically identical.

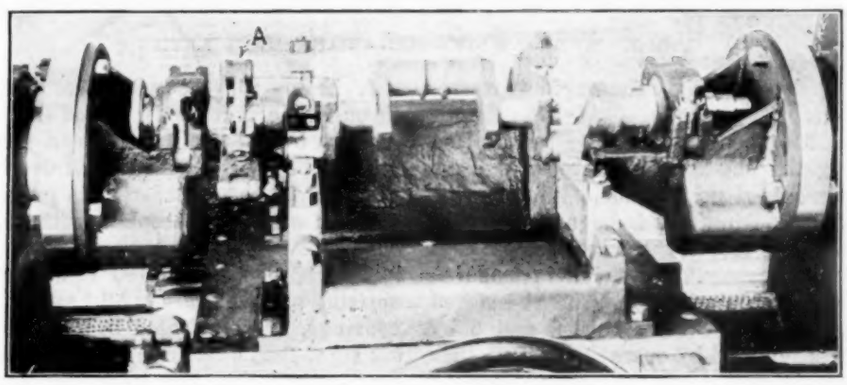


FIG. 1. TOOL SET-UP ON DUPLEX LATHE

The duplex machine is built with double-end drive to minimize the "lag" or torsional deflection which results from driving entirely from one end. With single-end drive this "lag" begins to show its effect after the first pin has been turned and will usually increase with each successive pin turned until the center is reached, after which the "lag" will decrease.

The shaft is not carried on centers but by substantial bearings in the pot-chucks. The duplex machine as shown in the headpiece is tooled for turning pins Nos. 1 and 6, while Fig. 1 is a close-up view of the tooling for pins Nos. 2 and 5. The tool carriage of the duplex machine consists of a double pair of toolposts, each pair situated in line with the pin they are to turn and spaced from 6 to 7 in. apart so as to allow room for inserting and removing the work. A broad-nose tool is carried in each front post and is of sufficient width to turn the full lengths of the pins, with the exception of about ¼ in. on each end in addition to the small portion devoted to the fillet. This portion together with the two end fillets is turned by a double tool carried in the rear toolpost.

The machine is fitted with an electrically operated rapid cross-traverse on the carriage which traverses the tools at a speed of 1 in. per second. This movement is claimed to be fool-proof, as the operating switch automatically opens upon removal of the operator's hand.

In operation on a six-throw crank, for example, it is customary to turn first the two bearings, styled Nos.

Penn., Philadelphia—The J. R. Kendrick Co., 25 Herman St., has awarded the contract for the construction of a 3 story, 60 x 125 ft. factory, for the manufacture of elastic hosiery, on Germantown and Pastorious St.

Penn., Philadelphia—The Standard Tin Foil Corporation, c/o Austin Co., Eng., Bulletin Bldg., has awarded the contract for the construction of a 1 story, 130 x 260 ft. factory on Cedar and Tioga St. Estimated cost, $85,000.

Penn., Scranton — The Klots Throwing Co., c/o Lockwood Greene & Co., Arch., 101 Park Ave., New York City., will soon award the conract for the construction of a 2 story, 116 x 200 ft. factory for the manufacture of silks.

SOUTHERN STATES

Ky., Bowling Green—The Atlantic Producing and Refining Co., recently organized with a capital of $1,500,000, has purchased and will develop oil properties, also build additions to plant for refining petroleum, manufacturing lubricating oil and wax. W. G. Williams, Pres.

N. C., Durham — The Durham Hosiery Mills will soon award the contract for the construction of a 4 story, 80 x 125 ft. mill. J. S. Sinine, Greenville, S. C., Arch.

N. C., Greenboro — The Pomona Mills, Inc., will soon award the contract for the construction of a 1 story, 60 x 110 ft. mill. J. E. Sirrine, Greenville, S. C., Arch.

N. C., Mabane—The Durham Hosiery Mills, Durham, plans to build a 2 story, 106 x 300 ft. hosiesy mill, here. J. E. Sirrine, Greenville, S. C., Engr.

N. C., Orangeburg—J. E. Sirrine, Engr., Greenville, S. C., will soon award the contract for the construction of a 1 story, 55 x 90 ft. cotton mill, for Santee Mill.

S. C., Bamberg — The Bamberg Cotton Mills will soon award the contract for the construction of a 2 story, 52 x 375 ft. cotton mill. J. E. Sirrine, Greenville, S. C., Arch.

MIDDLE WEST

Ill., Chicago — The Armour Fertilizer Works, Union Stock Yards, have awarded the contract for the construction of an acid plant. Estimated cost, $150,000.

Ill., Chicago—The Mutual Broom Co., 1505 South Halsted St., will soon award the contract for the construction of a 2 story, 100 x 125 ft. factory, on Ogden Ave. and Polk St. Estimated cost, $60,000.

Ill., Rockford—The Ziock Paper Box Co., South Wyman St., has awarded the contract for the construction of a 13 story, 70 x 104 ft. factory for the manufacture of paper boxes and hosiery, on South Main St. Estimated cost, $200,000.

Mich., Detroit—Feigenson Bros., 118 Benton St., has awarded the contract for the construction of a 3 story, 82 x 90 ft. bottling works, on Erskine and Beaubie St. Estimated cost, $30,000.

Mich., Grand Rapids — Sonneveld Bros., 815 Leonard St., N. W., plans to build a 2 story bakery and storehouse, on Leonard St., N. W., and Alpine St. Estimated cost, $40,000. P. Lindhout, 817 Lake Drive, Arch.

Ohio, Cincinnati—The Gibson Art Co., Elm St., has awarded the contract for the construction of a 6 story, 146 x 168 ft. factory and office building, on 4th and Plum St.

Ohio, Cincinnati—Stacey Bros., Gas Construction Co., 5535 Carthage Pike, plan to build a factory. Estimated cost, $200,000.

Ohio, Cleveland—A. A. Chilcote, 733 Prospect Ave., manufacturer of photo supplies, will soon award the contract for the construction of a 1 story, 100 x 140 ft. factory, on Superior Ave. Estimated cost, $30,000.

Ohio, Cleveland—The Cleveland Printing Ink Co., 1104 Prospect Ave., has awarded the contract for the construction of a 2 story, 40 x 99 ft. shop, at 1106 Hamilton Ave. Estimated cost, $50,000. F. O. Nitch, Mgr.

Ohio, Cleveland—The Lion Knitting Mills Co., 1051 Powers Ave., has awarded the contract for the construction of a 2 story, 83 x 95 ft. factory on West 25th St. and Meyer Ave. Estimated cost, $60,000. L. H. Enstein, Secy.

Ohio, Columbus—The Columbus Dental Co., 634 Wagner St., will soon award the contract for the construction of a 2 story, 38 x 100 ft. addition to its factory.

Ohio, Dayton—The Allsteel Ridewell Tire and Rubber Co., Dayton Saving and Trust Bldg., plans to build a 3 story, 100 x 200 ft. factory, for the manufacture of automobile tires. Estimated cost, $100,000.

Ohio, Elyria—The Winner Cord Tire and Rubber Co., 702 National City Bldg., Cleveland, has purchased a site here and plans to build a factory for the manufacture of cord tire. Estimated cost, $300,000.

Wis., Ft. Atkinson—The Creamery Package Manufacturing Co., Ft. Atkinson Bldg., has awarded the contract for the construction of a 2 story, 40 x 90 ft. enameling plant. Estimated cost, $25,000.

Wis., Manitowoc—Juul & Smith, Arch., Dempsey Bldg., will soon award the contract for the costruction of a 2 story, 75 x 175 ft. canning factory, for A. H. Franke, 1119 Columbus St. Estimated cost, $80,000.

Wis., Marinette—The American Toy Horse Co. plans to build two 1 or 2 story, 100 x 200 ft. factories, for the manufacture of toy horses. Estimated cost, $150,000. H. Greene, 425 East Water St., Milwaukee, Pres.

Wis., Milwaukee—The Walsh Harness Co., 330 First Wisconsin National Bank Bldg., has awarded the contract for the construction of a 1 story, 50 x 200 ft. factory, on Hubbard and Keefe St. Estimated cost, $60,000.

Wis., Racine—The Racine Confectioners' Machinery Co., 1630 Racine St., is having plans prepared by D. R. Davis, Arch., 526 Wisconsin St., for the construction of a 2 story, 50 x 165 ft. factory and a 1 story, 38 x 120 ft. machine shop. Estimated cost, $60,000.

Wis., Tomah—The Tomah Rubber Works, 176 16th St., Milwaukee, has awarded the contract for the construction of a 2 story, 100 x 100 ft. factory. Estimated cost,$45,000.

Wis., Waukesha—The Bethesda Mineral Spring Co., 301 Dunbar Ave., plans to build a 1 and 2 story, 40 x 60 ft. bottling plant. Estimated cost, $25,000. Van Ryn & De Gelleke, Caswell Blk., Milwaukee, Arch.

WEST OF THE MISSISSIPPI

Mo., St. Louis—The Southern Car Wheel Co., Railway Exchange Bldg., plans to build a 1 and 2 story 120 x 135 ft. factory, on Euclid Ave. Estimated cost, $400,000.

Okla., Sapulpa—C. R. Webb plans to build a flour mill here. Estimated cost, $50,000.

Tex., Dallas—The Monarch Petroleum Co., Western Indemnity Bldg., recently organized with a capital stock of $2,000,000, has purchased a 30 acre site and plans to build a 5000 bbl. refinery in West Dallas. Estimated cost, $500,000. J. R. Aiken, Pres.

WESTERN STATES

Calif., Emeryville (Oakland P. O.)—The American Rubber Co. will soon award the contract for the construction of a 2 story factory. Estimated cost, $100,000. W. J. Miller, 417 Market St., San Francisco, Arch.

Ore., Portland—The Crystal Ice and Storage Co., 432 East Salmon St., is having plans prepared by Camp & Du Puy, Arch., 426 East Alder St., for the construction of a 3 story, 110 x 115 ft. factory. for the manufacture of ice cream, on East 7th and Main St. Estimated cost, $125,000.

Ore., Portland—The Eagle Mill Co. is having plans prepared by J. V. Bennes, Arch., Chamber of Commerce Bldg., for the construction of a 7 story mill for the manufacture of flour and cereals, and a 1 story, 100 x 130 ft. warehouse. Estimated cost, $200,000.

CANADA

B. C., Sapperton—The Canada Western Cordage Co. has awarded the contract for the contraction of a 2 story, 150 x 200 ft. factory and warehouse. Estimated cost, $76,000.

Ont., Port Credit—The St. Lawrence Starch Co., has awarded the contract for the construction of a 4 story, 60 x 150 ft. factory. Estimated cost, $90,000.

Machine Tools Wanted

The following concerns are in the market for machinery and machine tools.

N. Y., North Tonawanda—The Buffalo Sled Co., 107 Woodward Ave.—equipment for the manufacture of sleds.

Penn., Philadelphia—The Federal Hosiery Mills, Janney and Cambria St.—machinery for the manufacture of hosiery.

Fla., Tampa—The Tampa Dock Co., 17th and 1st Ave.—punch and shear with 36 to 40 in. throat for ¾ in. plates and a set of from 8 to 12 ft. bending rolls for ¾ in. plate (used).

S. C., Charlotte—A. Garsed Co.—lathes and milling machines.

Ind., Indianapolis—O. N. Moore Co., East Washington St.—3 Hendy 6 x 14 Q. C. G. taper lathes.

1 Cataract 7 x 18 Q. C. G. bench lathe.
One No. 3 Brown & Sharpe universal miller.
One No. 3 Brown & Sharpe vertical miller.
1 hand miller.
One No. 3 Brown & Sharpe universal grinder.
One No. 1 Brown & Sharpe universal grinder.
One No. 1 Brown & Sharpe surface magnetic chuck grinder.
One No. 2 Brown & Sharpe surface magnetic chuck grinder.
One No. 1 Norton tool and cutter grinder.
One No. 75 Heald internal magnetic chuck grinder.
One 16 to 24 in. Blanchard magnetic chuck vertical rotary surface grinder.
One emery stand, 1 to 10 in. wheels.
One No. 14 Cochrane-Bly shaper.
One 20 in. G. & E.-B. G. shaper.
One 16 in. G. & E.-B. G. shaper.
One 8 ft. x 28 x 28 in. Gray Cincinnati planer.
One ¾ in. capacity drill.
One 20 in. capacity drill.
One 24 in. capacity drill.
One Rearwin filing machine.
Six 3½ in. Prentiss swivel base vices.
Six 4 in. Prentiss swivel base vices.
Hardening equipment for above.
One 10 h.p. 220 volt, 3 phase motor.
One 100 ft. 2⅞ shafting with flanged couplings.
Sixteen 18 in. hangers roller or ring oil bearings.
Belting and pulleys for above.
It will be noted that the make of machines is preferred, however, quotations will be acceptable on good standard substitutes.

Mich., Detroit—Feigenson Bros., 118 Benton St.—bottling machines, washers, etc.

Mich., Detroit—The Hup Motor Car Co., Milwaukee and Mt. Elliott Ave.—crane, traveler and conveyors.

Ohio, Cincinnati—The Marsh Murdock Coal Co., Stanton and Melish Ave.—conveyor.

Ohio, Cleveland—The Bender Auto Body Co., c/o H. Bender & M. Elben of Northern Blower Co., Barberton Ave.—special stamping machinery.

Ohio, Cleveland—The Cleveland Printing Ink Co., 1104 Prospect Ave.—ink grinding and pressing machines.

Ohio, Cleveland—The Guide Motor Lamp Co., 11400 Madison Ave.—special stamping machines, presses and cutting machines for brass work.

Wis., Milwaukee—The Bethesda Mineral Spring Co., 301 Dunbar Ave.—bottling machinery.

Wis., Milwaukee—The Federal Textile Co., 1306 First Wisconsin National Bank Bldg.—knitting machinery.

Wis., Milwaukee—The Ludwig-Wolf Ice Cream Co., 608 Caswell Bldg.—refrigerating machinery.

Wis., Milwaukee—The Milwaukee Brush Manufacturing Co., 51 Erie St.—woodworking machinery.

Wis., Racine—The Harvey Spring and Forging Co., 17th and Murray St.—traveling crane.

Colo., Colorado—The Strang Garage Co., 26 North Nevada Ave.—No. 60 Heald cylindrical grinder (new).

Mo., St. Louis—The Counts Soap Co., 5236 North Market St.—1 grease container, 1,500 gal. capacity, 3 sets acetylene welding outfits, 1 punch press, 23 thermometers and 6 or 7 electric trucks.

Mo., St. Louis—The Rown Electric Manufacturing Co., c/o W. Lesseig, Pur. Agt., 713 Star Bldg.,—eleven 10 x 26 in. lathes, four No. 4 plain millers, one small speed lathe, six bench drills, one geared head turret lathe, one or more 1 in. bolt cutter, one 12 in. shaper. Hangers, belts, pulleys, conveyors, etc.

Ont., Toronto—Baldwins Limited, Ashbridge Bay—crane and machinery for the manufacure of steel plate.

Ont., Toronto—The A. R. Williams Machinery Co., Ltd., 64 Front St., W.—No. 2 Fosdick horizontal boring mill or similar (new).

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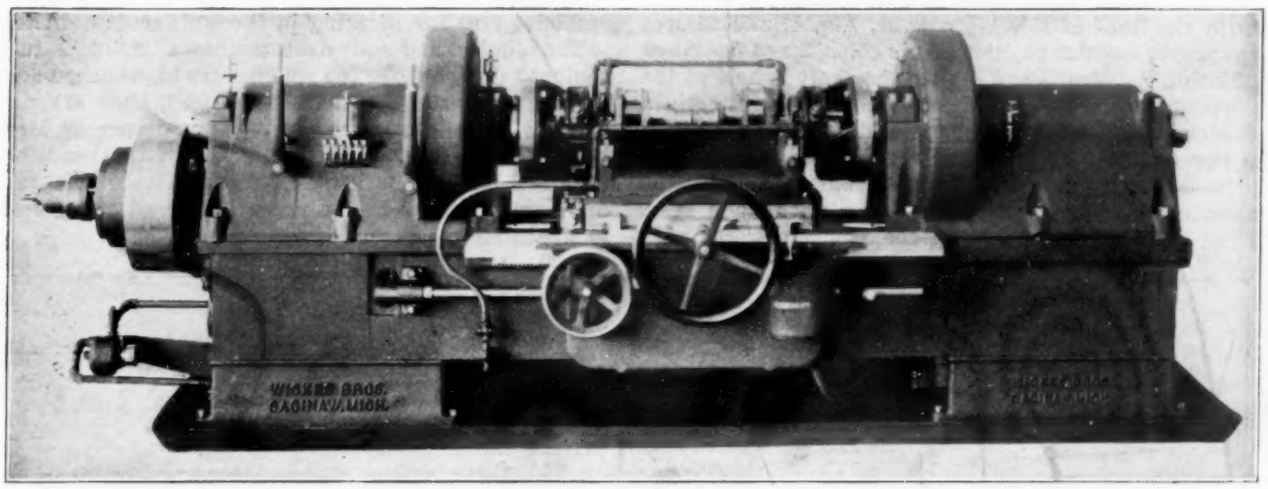

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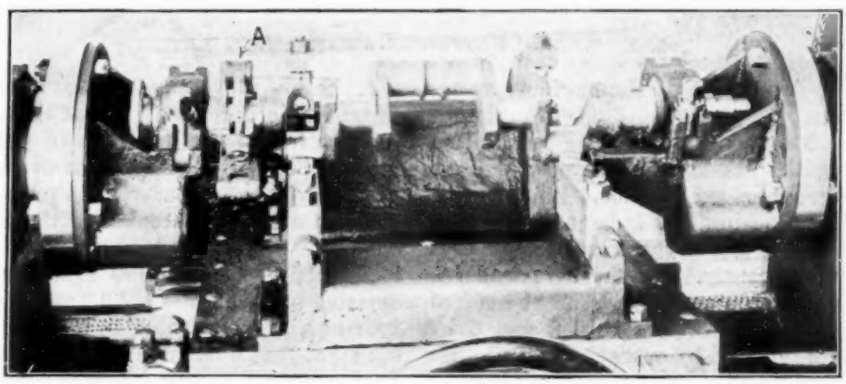


FIG. 1. TOOL SET-UP ON DUPLEX LATHE

The duplex machine is built with double-end drive to minimize the "lag" or torsional deflection which results from driving entirely from one end. With single-end drive this "lag" begins to show its effect after the first pin has been turned and will usually increase with each successive pin turned until the center is reached, after which the "lag" will decrease.

The shaft is not carried on centers but by substantial bearings in the pot-chucks. The duplex machine as shown in the headpiece is tooled for turning pins Nos. 1 and 6, while Fig. 1 is a close-up view of the tooling for pins Nos. 2 and 5. The tool carriage of the duplex machine consists of a double pair of toolposts, each pair situated in line with the pin they are to turn and spaced from 6 to 7 in. apart so as to allow room for inserting and removing the work. A broad-nose tool is carried in each front post and is of sufficient width to turn the full lengths of the pins, with the exception of about $\frac{1}{4}$ in. on each end in addition to the small portion devoted to the fillet. This portion together with the two end fillets is turned by a double tool carried in the rear toolpost.

The machine is fitted with an electrically operated rapid cross-traverse on the carriage which traverses the tools at a speed of 1 in. per second. This movement is claimed to be fool-proof, as the operating switch automatically opens upon removal of the operator's hand.

In operation on a six-throw crank, for example, it is customary to turn first the two bearings, styled Nos.

1 and 6, one of which is afterward used as an index of angular position in turning the remaining four bearings. The indexing is accomplished by a clamp on one of the pot-chucks, lined with hardened-steel pads, which grips the finished No. 1 pin at *A*, Fig. 1, and secures the proper angular position of pins Nos. 2 and 5. When finishing the Nos. 3 and 4 pins, the shaft is held at the inner line-bearings by clamps and angular position given to pins Nos. 3 and 4 by a clamp holding the No. 1 pin.

For feeding the tools into the cut the tool block is provided with power-traverse feed, but in practice the operators find they can work faster with hand feed. After finishing the cut with the front tools the rear tools are brought up by means of the rapid traverse, for cutting the fillets.

Previous mention has been made of the use of this machine for turning the cheeks of the webs, and for this the rapid traverse is of great value. When only a rough cut is used for cheeking this is begun on throws Nos. 1 and 6 with a double tool in the front toolpost that cuts both sides simultaneously. Provision is made so that without removing the shaft it may be re-indexed and roughing cuts taken on throws Nos. 2 and 5 by the rear tool. This is followed by operations on another machine for the remaining throws.

Where both roughing and finishing cheeking cuts are required it is customary to make the first with the front tool and the latter with the rear tools; in which case only one pair of cheeks can be finished in each set-up. For another method the carriage is fitted with a double cross-slide operated by a right and left feed screw so that both the roughing and finishing cheeking tools are fed in together—one from the front and the other from the rear, with the roughing tool taking its cut slightly in advance. An automatic trip throws out the feed on the roughing cut ahead of the finishing cut, while the latter proceeds to the finish.

The universal machine, Fig. 2, is similar to the duplex, except for the tooling and pot-chucks. The machine turns one pin at a time and usually uses a narrow tool in front, which is fed across the pin. Sometimes this tooling is varied by the use of a double tool which approximately reduces this cutting time one-half. When the carriage reaches a stop at the end of the cut on each successive pin, the rear tool is in correct position to be brought forward to finish the fillets. The pot-chucks for holding the shaft are fitted to revolve on the faceplates and have pins for indexing in three different positions.

The duplex and universal machines are sold fully equipped for the job. The spindles are high-carbon steel forgings and run in bronze bearings. They are provided with ball-thrust collars and are driven by large herringbone gears. The spur gears in the headstock are of 3½ per cent. nickel, heat-treated steel. The main drive shaft is of the same material, turned and ground to size.

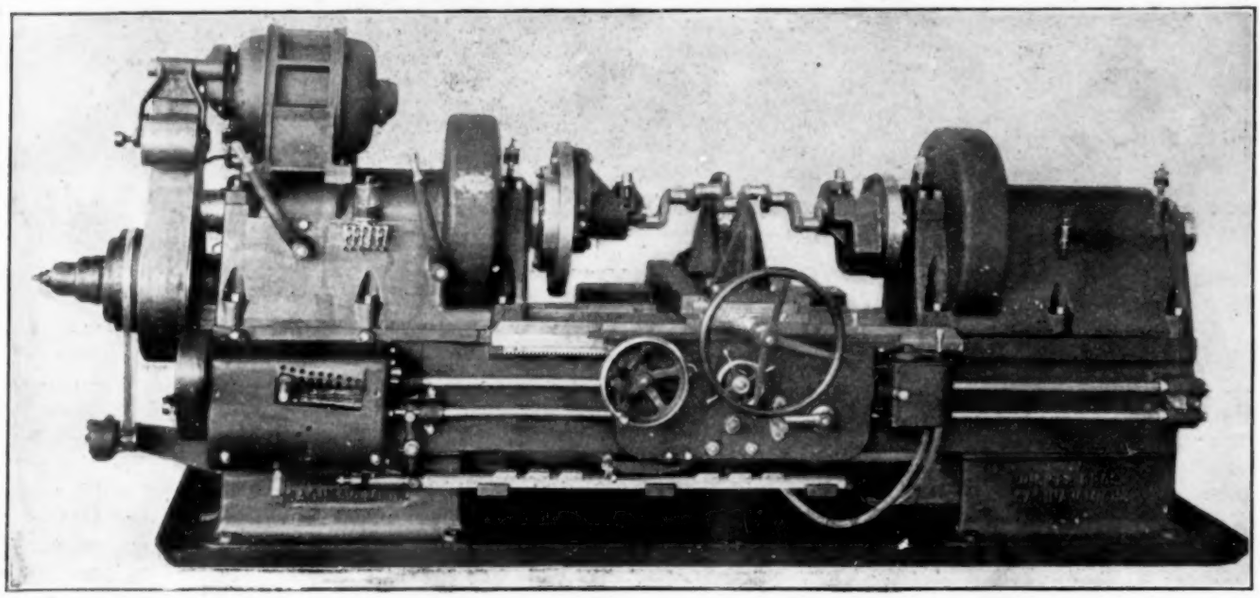


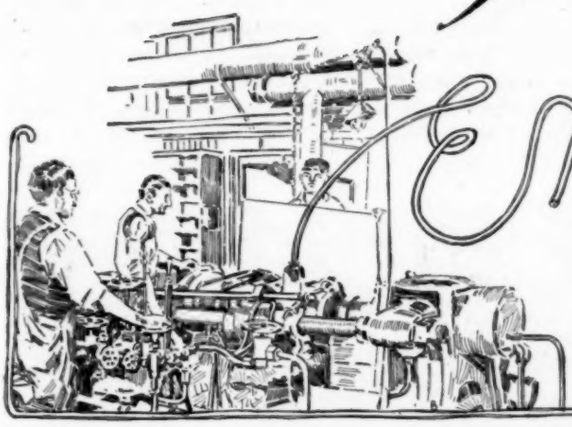
FIG. 2. WICKES UNIVERSAL CRANKSHAFT LATHE

A heavy nickel-steel drive shaft runs lengthwise through the center of the bed connecting the drive of the two headstocks and runs in phosphor-bronze bushings. The herringbone pinion driving the spindle gear of the right-hand headstock is provided with an adjustment to align its faceplate with that on the left-hand head.

Two speeds, 75 to 100 r.p.m., may be obtained by shifting sliding gears. All bearings, except the spindle bearings, are lubricated by a gang oiling system with six sight-feed oilers, which is shown at the front of the headstock in the headpiece. The lathe can be started or stopped by a lever on the apron or another on the headstock. One motion starts the machine and the reverse throws in an automobile type of brake which brings the spindle to an almost instantaneous stop. The clutch is of the Hillard double-disk type which has no predetermined point of contact.

The cross-slide is taper-gibbed at three places on the carriage, and the carriage is taper-gibbed at two places on the bed.

The drive pulley runs at 400 r.p.m.; is 20 in. in diameter, and has a 6½ in. face. It is equipped with Hyatt roller bearings. Both the duplex and universal machines are usually motor driven through a short belt provided with a tightener, as shown in Fig. 2. The motor is 15 hp. with a speed of 1200 r.p.m. The machine is furnished with or without a feed box as may be desired, and, when so equipped, has 36 feeds. The weight is 12,000 pounds.



The Extrusion of LEAD PIPE

By
Ellsworth Sheldon
ASSOCIATE EDITOR, AMERICAN MACHINIST

II. Directional Control

Bending lead pipe is easy, but bending without distorting it is quite another problem when the bends are to be produced in large quantities. Until the invention of the Du Bois trap extrusion machine, by means of which the direction of extrusion is under close control of the operator, the making of traps and bends was a much more complicated process than it is now.

A MODIFICATION of the extrusion process is used in the manufacture of the traps which are used on all waste pipes, to form a water seal against sewer gas entering the buildings which they serve. A drawing of the machine[1] for extruding these traps is shown in Fig. 11 and a photograph of the machine in operation in Fig. 12. It is a horizontal hydraulic press with two opposed cylinders and a double-end mold located between them. In this figure *A* is the mold and *BB* are the hydraulic cylinders. The control apparatus is located at *C* and consists of valves for admitting and discharging water to and from each cylinder separately, and a control valve operated by the lever *D* which admits water to both cylinders simultaneously but in quantities varying according to the position of the lever.

Fig. 13 shows a section of the mold of the trap machine. These molds are of different sizes and are interchangeable. They rest upon the tie rods which hold the two hydraulic cylinders together and are located by nuts threaded upon these rods. As the pressure upon a mold is practically balanced, the only duty devolving upon the nuts is to hold the mold against the preponderance of pressure required to curve the extruding pipe.

A partition divides the two cylindrical receptacles which form the mold, this partition extending partly into the outlet through which the lead is extruded. The die is held in the outlet by fillister-head screws, or, in smaller machines, threaded into the opening, and the core fastens into the top of the partition, its upper end coming flush with the top of the die.

The core is of a peculiar fluted section and there are wings or partial partitions on the inner walls of the extrusion chamber, the effect being to partly divide the flow of metal into four streams which join just before reaching the die. Now, if the pressure is equal upon the two cylinders, an equal amount of metal will flow from each side and the result will be a straight pipe, but if there is a preponderance of pressure and consequent flow of metal from one side or the other the pipe will curve sharply away from the side of greatest flow.

With the machine in Fig. 12 extruding pipe of a

[1]This machine was fully described on page 153, vol. 40 (Jan. 22, 1914), *American Machinist*.

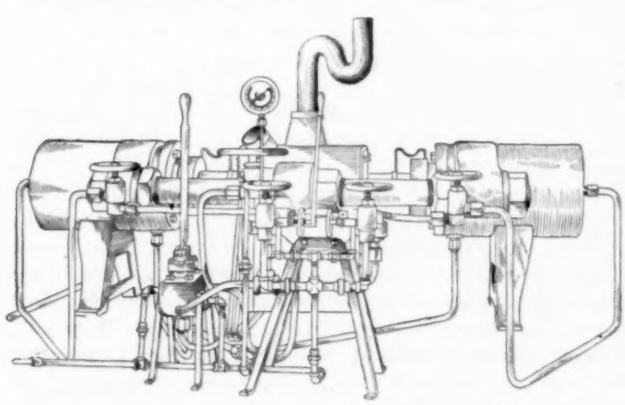


FIG. 11. DRAWING OF TRAP-EXTRUDING MACHINE

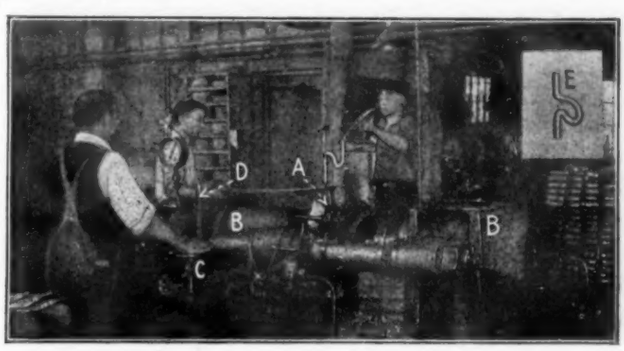


FIG. 12. TRAP MACHINE IN OPERATION

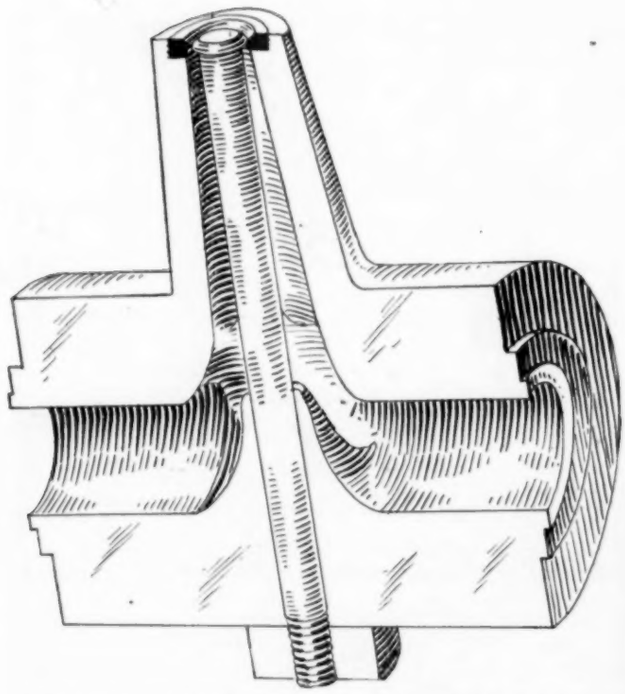


FIG. 13. SECTION OF MOLD OF TRAP-EXTRUDING MACHINE

diameter of one inch, it is quite practical by throwing the control lever to its extreme position and holding it there, to coil a continuous helix of pipe as small as 4-in. mean diameter. It would be necessary only for the helper to seize the first turn of pipe in his tongs as it came from the machine and draw it toward him to bring it into helical form and prevent it from piling up on itself in the form of a spiral.

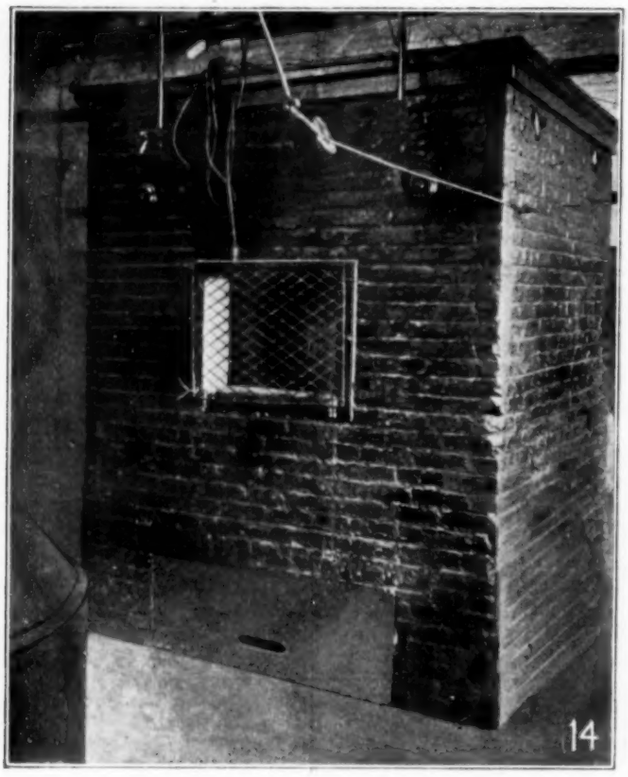


FIG. 14. OVEN FOR HEATING THE CABLE

To form a trap, the operator moves the control lever first in one direction and then the other, being guided solely by the appearance of the extruding pipe which will follow the movements of his hand as obediently as if endowed with intelligence.

It requires a considerable degree of skill to manipulate the trap machine, as it is solely a matter of the hand and eye working in conjunction; there is no mechanical guide for the operator.

Any bend or combination of bends within the single plane may be made, the limit being when the part already extruded becomes so heavy that its own inertia could cause it to distort when following the quick

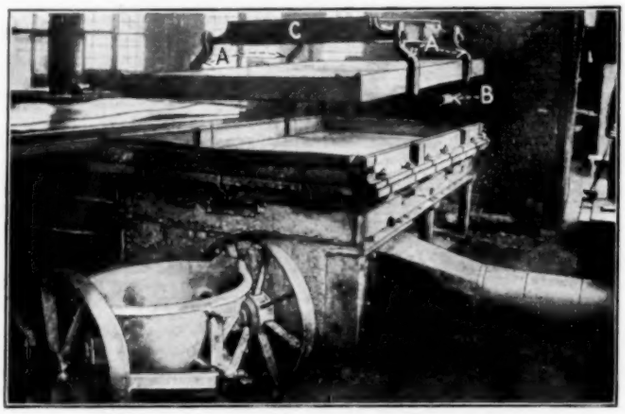


FIG. 18. A 10-TON SLAB OF LEAD

changes in direction caused by the machine. The "bag trap" shown at *E*, Fig. 12, is a good illustration of what can be done, the only movement necessary to produce this piece being a leisurely movement of the operator's hand on the control lever. The sole duty of the man standing back of the machine is to grasp each piece with the tongs and when it is extruded to the correct length, saw it off, which he does with three or four quick strokes of a common rib backed saw. The flow of pipe does not stop for an instant until the mold is exhausted.

Correcting Tendency To Bend in Wrong Plane

If the lead is of even temperature all the way round the outlet and the die is perfectly polished there will be no tendency for the pipe to bend in any plane other than parallel to the hydraulic cylinders, but these conditions cannot always be maintained and sometimes there will be trouble from bending in a direction at an angle to the one desired. The job of the third operator who is leaning upon one of the cylinders is to keep his eye on the extruding pipe and if it shows a tendency to deviate in a wrong plane from a vertical path he promptly dashes water upon the outside of the curve with a swab which he holds for that purpose, and the refractory pipe will straighten up as if by magic. The sudden cooling of the lead upon the side that is flowing too fast is what accomplishes the result.

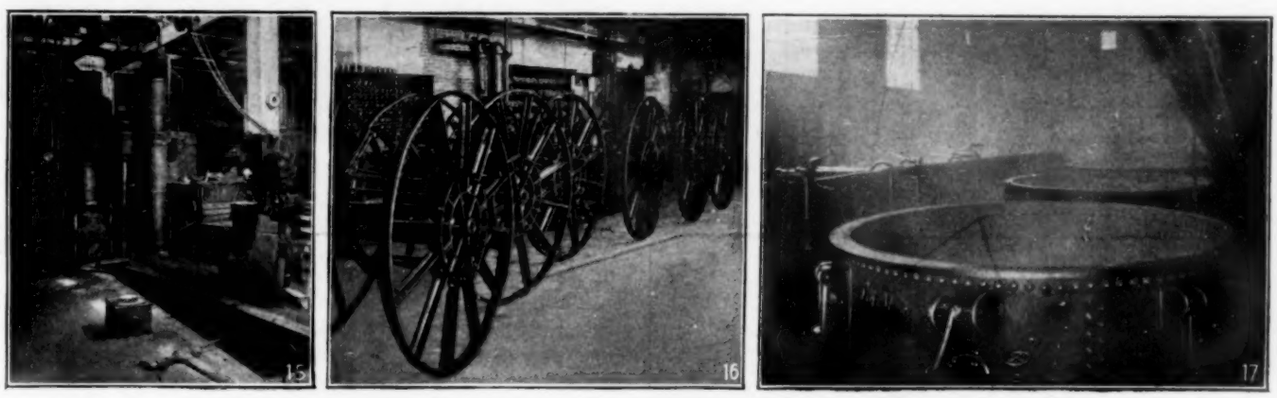
The number of traps that can be made at one filling of the mold depends upon their diameter, length, and thickness of wall. When a mold is emptied, the rams are drawn back (by hydraulic pressure), stopping just within the cylindrical part of the mold. In this position a pouring gate is exposed, which allows the mold to be refilled from a ladle.

Another application of the extrusion processes is the

covering of cables of telephone, electric lighting, and other wires that run under the streets of our cities or sometimes in aërial lines across country.

The cable-covering machines are hydraulic presses similar in principle to the pipe presses, but inverted. In the pipe press the mold is carried on the press ram and moves upward with it, while in the cable-covering machine the mold is stationary and the plunger which forces out the lead is attached directly to the ram of the press. The extrusion in this machine is through an opening in the side of the mold instead of through the plunger, which in the cable-covering machine is solid.

A corresponding hole in the opposite side of the mold admits the cable, and the inside of the mold is so formed that there is no tendency for the lead to escape in that direction. The cable itself passes from a reel at the rear of the press through the mold (coming out of the opening, where the lead is extruded), and is kept under tension by a power-driven reel in front, the flow of lead forming a pipe around the cable which easily carries the latter forward with it. The cable itself takes the place of the core of the pipe machine.



FIGS. 15, 16 AND 17. REELS, VATS, AND OVENS USED IN IMPREGNATING CABLES
Fig. 15—The cable-armoring press. Fig. 16—Iron reels on which the cable is wound to be impregnated.
Fig. 17—The impregnating vats.

"Impregnating" the Cable

Before coming to the covering, or "armoring" presses, the cable, reel and all, is immersed in a huge vat of impregnating fluid resembling boiling pitch. The object is of course to saturate the fiber covering of the individual wires and units with a material impervious to moisture and resistant to ordinary causes of deterioration.

The cables are suspended in the hot solution for several hours until they are thoroughly impregnated, when they are ready for their lead covering. As it is not always practicable to send a cable directly from the impregnating vats to the armoring presses, and as the impregnating compound becomes stiff and unyielding when cold, it is necessary to provide means of reheating the cable immediately before it receives its lead armor.

For this purpose there is located back of each press a steam-heated brick oven large enough to receive a reel of cable. One of these ovens is shown in Fig. 14, while in Fig. 15 may be seen one of the armoring presses with its melting furnace. The next press to the right in this latter picture is partly hidden behind the post, but a corner of its heating oven may be seen in the background.

The hydraulic cylinder of the press is at the top of the machine and the lead mold at the bottom with the opening from which the cable is extruded at about the floor level. A sunken tank in front of the press is kept full of water through which the cable passes for the double purpose of cooling the lead covering before it is wound on the receiving reel, and for seeking out possible defective places in the armor.

Each section of the cable is subjected to electrical test after coming from this operation and if a defect exists in the covering that allows water to penetrate to the wires, it will be disclosed and remedied at this time instead of making trouble after the cable is in service. Figs. 16 and 17 show respectively the iron reels on which the cable is wound, and the impregnating vats. These reels are the ones that carry the cable in the heating ovens back of the armoring presses. As the cable with its lead covering comes from the presses it is wound directly onto the wooden reels upon which it is shipped.

Contrary to what might be expected, the lead in the mold is not in a molten state either in the trap machine, pipe or armoring presses; in fact, in the case of the two latter it is perfectly practical to extrude cold metal, the only difference being the higher pressures required. The flowage of the metal in the die generates a considerable degree of heat, so that molten metal instead of cooling in the die would come out in a shower rather than in a continuous piece.

After the molten lead has been run into a mold, a certain time is allowed for it to solidify, the aim being to extrude it at that temperature where it is in a plastic state, taking form readily and yet possessing sufficient cohesion to allow it to maintain its shape.

In the trap machines it is necessary to keep a gas flame on the mold in order to maintain the best working temperature, while on the pipe presses quite the contrary condition prevails and many of the molds are water jacketed.

Rolling Sheet Lead

The rolling of sheet lead presents some interesting problems, not the least of which is the handling of the heavy weights involved. In Fig. 18 may be seen the cast ingot ready for the mill. This picture also shows the permanent mold for casting, the furnace in the background for melting the metal, and the means provided for handling the mass of lead.

This ingot is 6 x 19 ft. in size and nearly 6 in. thick; it therefore weighs in the neighborhood of 10 tons.

Four hooks, marked AAAA in the picture, are set

into corresponding recesses in the mold before pouring the metal. A valve inside the kettle, which may be seen back of the mold, allows the molten lead to flow out of the spout B directly into the mold.

When the latter is level full and the flow stopped, all dross and impurities are carefully raked off the surface and the slab allowed to set. The pouring is so timed that the slab will have assumed the proper working temperature at about the time the mill finishes rolling the previous piece.

The frame *C* is now connected with the hooks *A*, the crane attached and the slab lifted out and deposited on skids where the top surface is scraped to remove any dirt or other foreign substances that would otherwise be imbedded in the metal when passing through the rolls.

The mill is shown in Fig. 19. The lower main roll and each alternate small roll on the bed of the machine

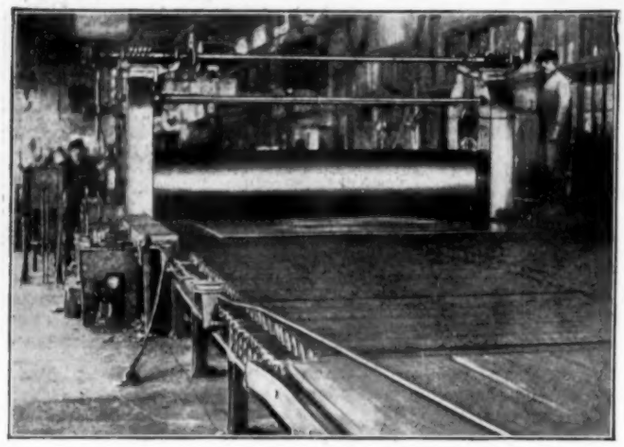


FIG. 19. ROLLING THE SLAB INTO SHEETS

are positively driven by a powerful reversing motor under control of the operator at the left of the machine. The crane picks up the 10-ton slab shown in Fig. 18 and places it on the small rollers, which pass it back and forth between the reducing rolls until it is brought to the requisite thickness.

The upper reducing roll is raised and lowered by an independent motor, and when the slab is first put into the mill this roll is set down 0.015 or 0.020 in. at each pass, the amount of reduction being gradually lessened until on the final passes the reduction may not exceed 0.001 in. per pass, but by this time the slab will have been reduced to sheets $\frac{1}{8}$ in. in thickness. Four such slabs can be reduced to $\frac{1}{8}$-in. sheets in one day.

For their kind assistance and coöperation and for the facilities placed at his disposal in securing photographs and information relative to the machinery and processes described in this article, the author is indebted to T. G. W. Fine, of the United Lead Co.; A. R. Von Keller of the National Conduit and Cable Co., and Milton Lissberger, of Marks, Lissbergers Sons.

Circular Milling on a Straight Table

BY FRANK C. HUDSON

The motor vehicle has so many parts which present new machining problems that they afford great opportunity for special fixtures and for the adaptation of standard machines, in cases where the quantity of the product is not sufficient to warrant having special machines built for the purpose. A case of this kind is

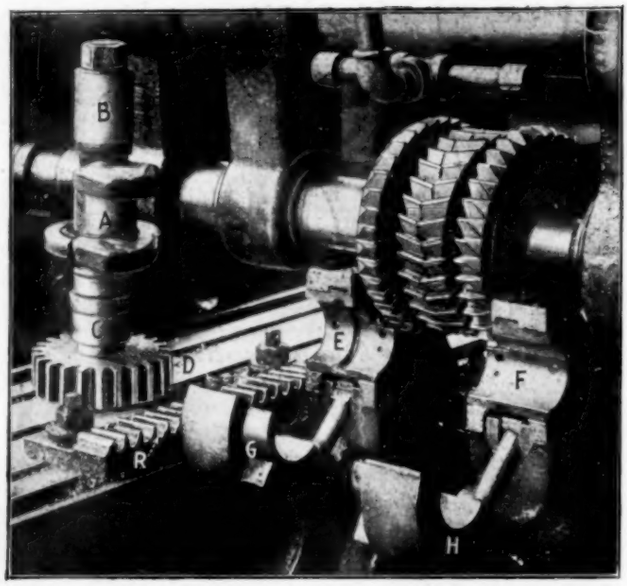


FIG. 1. THE CUTTERS AND FIXTURE

shown in a special fitting for a Pierce-Arrow truck, where it is only necessary to finish the piece on a part of its circumference and the inside of the cheeks.

The first operation bores a hole through the barrel of the piece, *A*, Fig. 1, which is then placed on the mandrel shown together with the journals *B* and *C* at each end of the work. This mandrel contains also the gear *D*. This assembly fits into the bearings *E* and *F* and is held in position by the clamps *G* and *H*.

These clamps carry a half bearing, and when swung into position are held by bolts as shown in Fig. 2. With the work mounted in the position shown, the gear *D* meshes into the rack *R*, which is bolted to the table of a Kempsmith milling machine. It can readily be seen how the action of the gear and rack will revolve the work against the milling cutters by simply throwing in the regular longitudinal feed on the table. Various modifications of this can readily be devised to handle work of a similar nature.

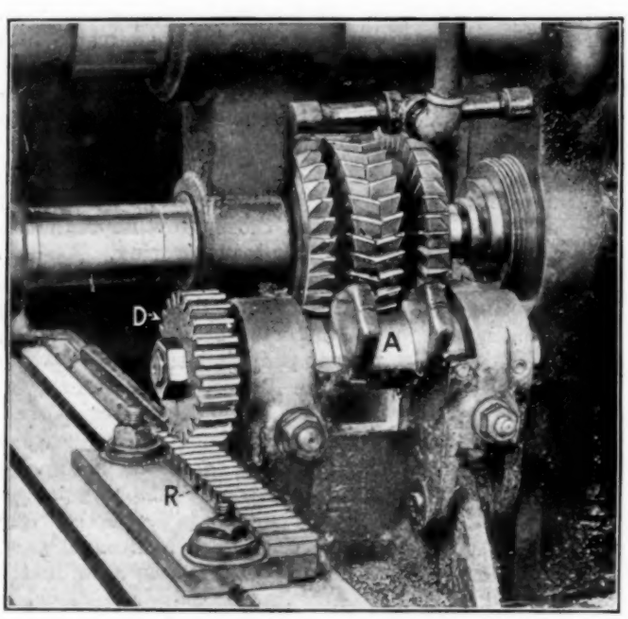


FIG. 2. THE FIXTURE AT WORK

Extracts From Chordal's Letters

In this letter Chordal tells about a very ingenious device for counting revolutions, the action of which is surprising. He also tells us something about the genesis of a well-known positive-pressure blower which goes to show that a device may eventually be used for a purpose entirely different from that intended by the inventor. An instance of a limiting factor in the use of labor-saving machinery and the passing of an old-time household article are also mentioned.

Mr. Editor:

* * * There are lots of different kinds of revolution counters to be put on machines to indicate the speed at which they are running, these devices consisting of some sort of mechanism which is connected with the machine whose speed is to be counted. But there is a new-fangled revolution counter, a "tachometer" as it is called, which is peculiar in that while it has to be connected with the machine whose speed is to be counted, the connection does not necessarily involve any mechanical moving parts, and it will answer if the tachometer is simply set or hung on the machine.

* * * The tachometer is based on the theory that if you have a lot of elements which can vibrate and each has some different rate of natural vibration, a certain one of them will vibrate only in response to vibrations at that given rate. We often notice at home in the evening that a certain window pane will vibrate when a certain locomotive passes. This means that the rate of vibration of that window pane is the same as the rate of repetitions of the exhaust or some other rattle of that particular locomotive. Some other locomotives, or that particular one, running at some different speed, will cause some other window pane to rattle.

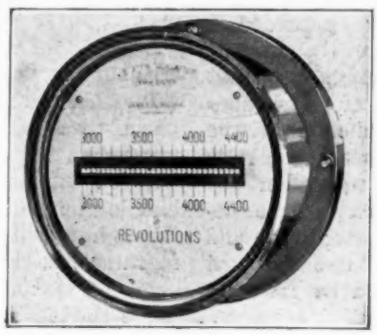


FIG. 1. A VIBRATING TACHOMETER

* * * The tachometer that I am speaking of is illustrated in Fig. 1, in which we see the ends of a series of flexible tongues, and if we notice which tongue is vibrating, the scale on the instrument will show the speed of the vibration of the machine whose rate of vibration this particular tongue responds to. Fig. 2 represents a turbo-generator with a tachometer setting upon it, or merely bolted to it. While the revolving member of a turbo-generator is gotten into as nearly a perfect balance as is practicable there is still some little shake about the thing, and the tachometer will recognize this shake and its particular tongue, which is appropriate to that rate of shaking, will vibrate, and the rate can be read upon the scale. As speed changes, that particular tongue will cease vibration and some other tongue will vibrate and indicate the speed. In a turbine subject to variations in speed the face of the tachometer may be watched and it will be observed that one of the tongues vibrates and then quits and another starts to vibrate, and so on, the changes of speed of the turbine being indicated as the zone of vibration runs along or changes position on the series.

* * * The makers of this very peculiar tachometer make a little demonstrating instrument, Fig 3, to illustrate its workings. In this little demonstrating instrument there are six flexible steel tongues of different lengths, and their bent free ends are colored white so that their vibration may be readily appreciated. The shortest tongue is about 2½ in. long, and the longest one, about 2¾ in. long, intermediate tongues being of intermediate lengths. The tongues are about $\frac{1}{32}$ in. in thickness and about $\frac{1}{8}$ in. wide. The roots of these tongues are anchored in a fixture mounted fixedly on a ring which is provided with a handle, and in this ring freely revolves a little wheel. The wheel has a hole at one portion of its rim so that the wheel is thrown out of balance, and the spindle is arranged to be started into rapid motion by a string, the same as a boy spins a top.

* * * You take this little instrument in your hand and set the wheel spinning. Being out of balance the result is that a little shake or vibration is given to the whole instrument. We do not know and do not care at present about the rate of rotation of the wheel. It runs so fast that none of the tongues vibrate. After a while, as the wheel slows down, its rate of rotation will correspond with the natural rate of vibration of the shortest tongue, and that shortest tongue will vibrate. As the speed of the wheel slows down the first tongue ceases its vibration and the second tongue starts in, and so on till finally only the longest tongue vibrates, and finally its vibration will stop, the rate of turning of the wheel having gotten below the rate of vibration of any of the tongues.

* * * If we would go to the trouble to do it, we could ascertain what these various rates of vibration are and we could mark each of the tongues accordingly. That is all there is to this new-fangled tachometer which is really a simpler instrument than this demonstrating device, for you might take the wheel entirely out of the demonstrating device and then merely lay the device on the steam turbine or other machine, and if there were tongues enough and they had been marked, some particular one of them would vibrate and show the speed at which the turbine was running.

* * * Now the question is how much of a vibration is there about these tongues. A Cornell professor of mechanical engineering examined one of these demonstrating instruments in my office and, in advance of trial, he understood its principle perfectly. But he was asked how far the ends of these tongues would vi-

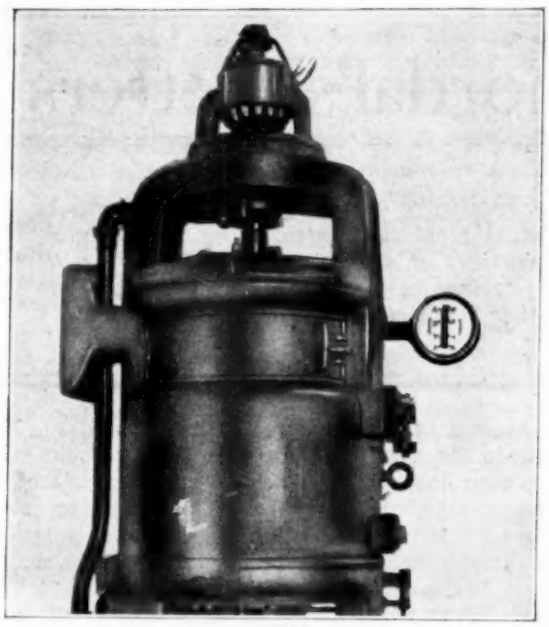


FIG. 2. THE TACHOMETER APPLIED TO A TURBO-GENERATOR

brate, and this set him thinking. He hazarded a guess at ¼ in. but seemed a little dubious about the vibration being that much, his theory being, first, that the instrument would not have the power to produce that much vibration and, second, the steel of which the tongues were made would not stand the punishment for any length of time. The instrument was then put through its paces, in the manner which I have described, and when the shortest tongue started in, lo and behold, it vibrated 2¼ in., and when it came the turn for other tongues their vibrations would be from 1½ to 2½ inches.

* * * Notwithstanding this very extended amplitude on the part of the tongues, I have never heard of a case of their breakage due to punishment.

* * * Mr. Johnston, the president of the Roots company, was telling me yesterday something of the early history of the Roots blower, a type of blower which is found the world over, the name Roots being applied to this well-known type.

The Roots blower consists of two impellers revolving in a casing and driven by external gears on their shafts, the lobes of the impellers sweeping the interior of the casing and touching each other as they revolve.

* * * At present Roots blowers are made with metallic impellers, but when they were originated by the Roots Brothers many years ago, their peripheries were formed of wooden staves fastened to spiders mounted on the shafts.

* * * It seems that the Roots Brothers invented this machine as a water motor, to take the place of big overshot wheels, etc. One of the machines was built and tried, but its wooden impellers swelled and choked, and required redressing. After they were dressed the machine was run idle to test its running, and Mr. Mullikin, the foundry foreman, happened to be standing near the outlet side of the machine and he got the benefit of the air blast. He at once said that that would be a good machine for the foundry to blow the air for the cupola.

* * * The machine was not a success as a water motor, and Mr. Mullikin's little speech proved to be a prophecy, for the Roots blower has for many years proved an eminent success in handling air and other fluid.

* * * Mr. Bookwalter was interested in the manufacture of harvesters, the Champion machine, I believe, but spent several years in travel, and at one time the Maharaja of Something in India, was showing Mr. Bookwalter his immense wheat fields while harvesting was going on. There was an army of native harvesters working by hand with cradles or sickles, binding the grain with straw bands made from the grain as cut. It was a wonderful sight for Mr. Bookwalter, who called the attention of the Prince to the fact that one of the Springfield machines would take the place of this whole lot of laborers and cut about 25 acres a day. "I know all about that," said the Prince. "I have seen your machines at work, and I have been in the Springfield factory and have seen them making the machines. They are wonderful machines, but how much does the twine cost for each acre cut?" Mr. Bookwalter was able to at once figure this matter out and told the Prince how much the twine cost, and then the Prince announced that the cost of this binding twine per acre was more than his entire present cost per acre for harvesting and, besides, what would these men do? They know nothing, they could not be mechanics or book-keepers, even if there would be some of such work to do.

* * * Those of us who are old enough can remember the days of the flail, before the threshing machines became fashionable. Did you ever try to handle one of these flails and, if so, did not you find it more awkward than the bricklayer's trowel? However that may be, you will now find very few men who know how to handle the flail, and I doubt if you could get a flail through a Chicago mail order house. The threshing machine has chased the flail out of existence.

* * * Happening to catch Mrs. Gordon doing some sewing with one end of her seam pinned to her knee, I called her attention to the sewing bird, the little metallic affair, bird shaped, that you clamp on the edge of the table and cause to open its mouth by pressing on the tail, the little bird holding the distant end of the seam. I promised the lady I would get her a sewing bird next day, and I started in with good intentions. No store that I visited had ever heard of the thing, and I later tried a number of stores in large cities, but it was no go. When I asked for a sewing bird the clerks would think I was kidding them. Getting in earnest, I advertised in the home papers, with the result that several old residenters brought in crude home-made sewing birds which they had had around home for generations. At Wanamaker's store, in Philadelphia, they told me that these sewing birds were French

FIG. 3. INSTRUMENT TO DEMONSTRATE THE PRINCIPLE OF THE TACHOMETER

and that their last importation had been about 20 years before the time of my inquiry. They later wrote me that they had imported a new lot, and I got one of them, and, about five years after my promise, I had the pleasure of giving it to Mrs. Gordon. It was the same old silver-plated looking bird of my boyhood, with a red pincushion on its back. The sewing machine had, in effect, chased these sewing birds out of existence, and I have often wondered how Wanamaker came to import the new lot, or what had kept alive their manufacture in France, though I can understand that in Europe the sewing machine is not the universal household implement that it is with us.

* * * Bert had gotten a roller trackway for unloading pig iron at the shop. The affair consisted of sections about 12 ft. long and a foot wide, with a series of rollers about 3 in. in diameter and 4 in. apart. One end of one of these sections would be poked into a railroad car, the other end of the section resting on a trestle where it joined a succeeding section, and so on until the sections reached out into the yard where the pig iron was piled. The affair would be down grade so that a man on the car would place a pig and start it down, while a man at the distant end would pick it up and pile it.

* * * When Bert stated to the yard foreman that this thing was coming the foreman kicked like a steer. He saw no use for the thing, and there was no reason why the men could not pick up the pigs of iron from the car and carry them off and pile them up. A strike came very near resulting from the introduction of this useful contrivance. But the thing came and it was put into use and it stayed in use, until after years of use, sections became broken, and it took time to get new ones from the factory. And then Bert had the time of his life arguing with the yard foreman who said that nothing could be done until these new parts came. Bert suggested that all that was necessary was to pick the pigs up from the car and carry them out into the yard and pile them up, the same as they used to do. But the yard foreman saw the possibilities of a strike.

Yours very truly,

CHORDAL.

Tap Drills, Clearances and Tolerances

BY WALTER J. RUDOLPH
Chief Engineer, Imperial Brass Manufacturing Co., Chicago, Ill.

The procedure recommended in this article for selecting tap drills for screw threads is based upon modern practice and takes into account several factors whose importance is recognized but which are not always allowed for in making a choice. Tables of clearances and tolerances are also included.

THE solution of the problem of cutting threads as it affects manufacturing in general, depends upon the selection of the proper size of tap drill for the internal thread and upon the clearance and tolerances applied to both threads. The lubricant used and the style of tool will have little effect, if any, when these other features have not been correctly taken care of.

The size of drill to be used depends not only upon the size of the thread but also upon the material to be threaded. The smaller the shank of the tap, the larger should the tap drill be so that the amount of material to be cut away will not present too great a resistance to the shank. The length of thread must also be considered as the long thread offers much more resistance than the short one. At the same time the shorter length of thread must be fuller or more perfect because of the smaller number of threads which are engaged. In Table I two classes are recognized, the short thread having a length equal to or less than its outside diameter, and the long thread including all other cases.

Likewise, two kinds of materials are specified, those easy to tap, such as cast bronze, iron, steel, aluminum, and wrought-and cast-brass, and those hard to tap, such as wrought bronze, aluminum, iron, steel, and wrought- and cast-copper. With the cast materials, a smaller drill may be used because of their granular structure which cuts and chips away rather readily and consequently makes the work of the tap easier while at the same time it makes necessary a more perfect thread because of its weakness. The more tenacious wrought materials are fibrous and difficult to cut and will require a larger drill to save tap breakage. They also are stronger and will not require so perfect a thread. It must also be remembered that these materials are more likely to tear if too full a thread is attempted.

SOME VARIATION EXPECTED

Some variation from these classes will of course be expected such as very soft brass or very hard steel, in which cases a larger drill would be used to prevent tearing.

The tap drills of the table will be found to give theoretically from 63 to 85 per cent. of full thread figured from the root of the thread to the tap drill. Actually these amounts will be increased from 5 to 15 per cent. because of the tendency of the metal to flow and fill up the root of the tap.

In the first column the lettered classes are purely arbitrary and are introduced for convenience only.

As an example of the use of the table, suppose we have to tap a $\frac{5}{16}$-in., 18-threads-per-inch hole in cast brass $\frac{1}{2}$ in. thick. This would fall in class G and as the material is easy to tap and the thread is long we should select a drill which will drill a hole of a size to produce 75 per cent. of full thread. To do this we determine the pitch diameter of the thread, *Pd* and double depth of thread *Dd* from tables or in any other convenient way.

Let *Pc* represent per cent. of thread specified in table and *Td* the diameter of tap drill. Then

$$Td = Pd - [(Pc - 50\%) \times Dd]$$

Td usually works out to a size which does not correspond to any standard drill. In most cases, however, a special tool is used which can be made exactly to size. If it is necessary to use a standard drill the nearest size to the calculated value should be chosen. This calculation applies to machine tapping. For hand tapping the value of *Pc* can be increased 10 per cent. be-

cause the operator can feel the pull of the metal and relieve it somewhat.

In view of the lack of a generally accepted standard of fits to be applied to internal and external threads, Table II has been prepared on the basis of modern manufacturing practice.

Class A or wrench fit would be applied to those cases

TABLE I. DATA FOR USE IN CHOOSING TAP DRILLS

Class	Diameter, Inches	Number of Threads per Inch	Per Cent. of Full Thread Materials Hard to Tap Short	Materials Hard to Tap Long	Materials Easy to Tap Short	Materials Easy to Tap Long
A	Not less than 1½ in.	8 thr. or less	76	72	81	77
B	Not less than 1 in.	10 thr. or less	75	71	80	76
C	Not less than ¾ in.	12 thr. or less	74	70	79	75
D	To ½, inc.	16 thr. or less	72	67	76	72
E	Over ½	16 thr. or less	74	70	81	78
F	To ½, inc.	20 thr. or less	68	63	73	68
G	To ½, inc.	20 thr. or less	76	72	79	75
H	Over ½	20 thr. or less	81	78	83	81
I	To ¾, inc.	24 thr. or less	68	63	74	70
J	To ¾, inc.	24 thr. or less	76	72	81	78
K	Over ¾	24 thr. or less	81	78	83	81
L	To ¾, inc.	30 thr. or less	74	69	79	75
M	To ¾, inc.	30 thr. or less	78	75	81	78
N	Over ¾	30 thr. or less	80	78	83	81
O	To ¼, inc.	More than 30 thr.	81	79	83	81
P	Over ¼	More than 30 thr.	83	81	85	83

where alignment is governed by the threads engaging with each other and should be a very exact job.

A class B or tight fit is one that would require a maximum of hand exertion to turn one thread into the other and would be used where a close fit is required without the use of a wrench.

Class C or hand fit is used for parts where the assembly depends somewhat upon the thread for the location of the respective parts. This class allows the threads to be turned by hand and also permits of machine assembly.

Class D or average fit applies to the general run of work and allows a tolerance to be applied which is practical for production purposes.

Classes E, F and G can be applied where a loose fit is permissible or possibly necessary.

Any fit looser than those specified would have to be treated as special with the type of work as the governing factor. The coarser the fit, the greater the tolerance that can be applied.

Figuring the Fits

In figuring fits, the first step is to specify the internal thread 0.002 in. larger than the pitch diameter because most commercial taps produce such a size after the keenness of the edge has been taken off. The external thread can then be based upon the class of fit as it is

TABLE II. SCREW-THREAD CLEARANCES AND TOLERANCES

Class of Fit	Average Clearance, Inch	Variation External	Variation Internal	Extremes Least Tol.	Extremes Greatest Tol.
A wrench	0.002	+0.0005 —0.0005	+0.0010 —0.0005	0.0010	0.0035
B tight	0.003	+0.0005 —0.0005	+0.0010 —0.0005	0.0020	0.0045
C hand	0.004	+0.0005 —0.0005	+0.0015 —0.0005	0.0030	0.0060
D average	0.005	+0.0005 —0.0010	+0.0005 —0.0005	0.0040	0.0075
E easy	0.006	+0.0005 —0.0010	+0.0020 —0.0005	0.0050	0.0090
F loose	0.007	+0.0005 —0.0015	+0.0020 —0.0005	0.0060	0.0105
G coarse	0.008	+0.0005 —0.0015	+0.0020 —0.0005	0.0070	0.0115

easier to change, most dies being adjustable while very few taps are.

The next step is to apply a proper tolerance to both threads as they are seldom, if ever, exactly to size. The tendency should be to keep the thread as near to size as possible and not to take advantage of the full tolerance.

The first two columns of Table II give the classes of fits and the recommended clearances. The column under "Variation" gives the plus and minus tolerances applicable to each fit. It will be noted that the greatest tolerances are applied where they can be utilized to the best advantage. The last column under "Extremes" gives the exact figures in either direction and shows that the parts would still fit together if the extremes were carried out in opposite directions.

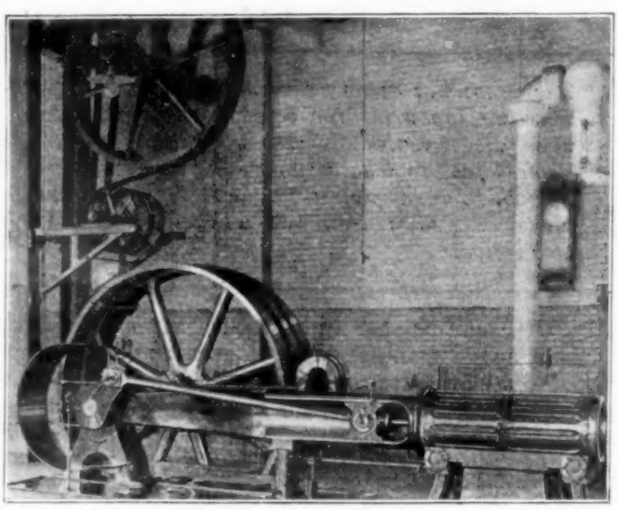
Larger tolerances are allowed for internal threads because of the lack of adjustment facilities in the tools used and because of the comparative difficulty of exact measurements.

An Unusual Belt Drive

By B. M. Davis

The halftone shows an unusual belt drive which has been in commission for several years and has given complete satisfaction. It drives three floors of a machine shop in Waterbury, Connecticut.

There are three belts on the main pulley of the engine. The one at the front drives a line shaft in the basement of the building. The center belt passes under



AN UNUSUAL BELT DRIVE

the front idler pulley on the jackshaft, over the large pulley above and back to the main pulley again.

The large pulley above is mounted on the end of the line shaft on the first floor. The idler for this belt is keyed to the jackshaft and the two turn together.

The belt at the back passes under the back idler pulley and over the pulley mounted on the end of the line shaft for the second floor. The back idler runs free on the jackshaft but as the front idler is keyed to and turns the shaft practically at the same speed as the back idler there is no "loose pulley trouble" here, the freedom of the back idler merely being necessary to take care of slippage of either belt. The jackshaft runs in boxes which can slide on the angle brackets. At the back of the columns to the left, a hand-operated gear affords means for adjusting the jackshaft bearings for the purpose of tightening the belts in case such adjustment becomes necessary.

Leading the belt in this manner gives about 75 per cent. contact on the driven pulleys.

Time-Saving Tube and Rod Chart

By MELVIN D. CASLER*
Production Engineer, National Conduit and Cable Co.

This article describes the construction and operation of a chart for calculating the weights of all sorts and shapes of rods and tubes. It should be a great aid to production men in speeding up calculations and also to designers, particularly in computations on tube reductions.

THE accompanying chart, Fig. 1, gives the weight per running foot of tubes and rods of any material and of any cross-sectional shape. It is also a reduction chart and tool chart as it shows directly the percentage of metal reductions in drawing from one set of dimensions to another, or from one shape to another, and will give both plug and die diameters as well as the corresponding gage and unit weight.

The straight parallel rulings indicate the outside diameters of tubes or rods of any shape or material—a rod being considered as a tube with an inner diameter of zero and a gage of one-half its diameter.

There are two sets of curved rulings—one representing the various gages, or tube wall thicknesses, and the other the corresponding inner diameters.

A tube of a certain outer diameter and gage is indicated on the chart by the point where those diameter and gage lines intersect; and that point also gives the corresponding inner diameter. Thus the intersection of the 1.0-in. outer diameter line with the 0.05-in. gage line occurs on the 0.9-in. inner diameter line.

The arm AB swings about the pin P which is rigidly fixed in the chart and the graduations of the arm record weights per running foot of any tube or rod denoted by the intersections of the chart graduations as explained above. The arm is pierced with holes, C_1, C_2, C_3, C_4, on a prolongation of its graduated edge. Hole C_1 is so located that when slipped over the pin P the unit weights recorded are those for round brass tubes or rods. The accompanying chart shows arm AB in this position. For example, it is seen from the position shown that the weight of a round brass tube having an outer diameter of 0.2 in. and a gage of 0.03 in. is 0.059 pounds per foot. If hole C_2 is placed over the pin the swinging arm will record weights per foot of round copper tubes or rods. Hole C_3 will likewise give weights of hexagonal brass tubes or rods and hole C_4 the same for brass squares.

The principle on which the chart is based is as follows: The straight-line chart rulings and the graduations on the swinging arm are both plotted to logarithmic scales; the spacings on the arm being one-half the corresponding spacings on the chart. Hence it follows that any interval on the chart normal to the straight rulings represents a constant factor and that an equal interval on the arm represents the square of that factor. Since the weight per foot of a solid rod varies directly with its cross-sectional area and that area varies with the square of the diameter, it follows that if we place the graduated edge of the swinging arm on any line normal to the straight-line rulings of the chart in such a position that some particular outer-diameter line shall be opposite the proper weight per foot of a solid rod of that diameter as denoted by the arm graduations, then with the arm in this position every outer-diameter line will intersect the graduated edge of the arm at a point indicating the weight per foot of a rod of that particular diameter.

In plotting the gage curves of the chart, the location of the hole C_1 in the arm AB is fixed at any convenient point on the prolongation of the graduated edge of AB and this graduated edge is then so placed on the line DE as to give the correct weights per foot of round brass rods in accordance with the preceding paragraph. The location of the pin P in the chart is fixed coincident with the hole C_1 in the arm AB with the latter in the above position. Then whenever the hole C_1 is slipped over pin P the arm will give weights per foot of round brass rods when swung to the line DE.

A pin P' may be located on line FG at the same relative position on FG as that occupied by the pin P on the line DE. Then when the hole C_1 is placed on the pin P' the arm will give rod weights when laid along FG.

To read the weight per foot of a round brass tube, the arm is swung so that its graduated edge passes through the intersection of the lines representing the known diameter and gage. That intersection will then register the correct weight on the graduated edge of the arm. The curved gage lines on the chart are plotted to satisfy this requirement.

The unit weight of brass assumed in computing the chart lines was 0.3064 lb. per cubic inch. If d represents the outer diameter of a round brass tube, g the gage and w the weight per foot; then

$$w = \pi \times (d-g) \times g \times 12 \times 0.3064 = 11.55\ g\ (d-g).$$

The gage curves of the chart are plotted from this formula with center C_1 on the pin P. For instance, to plot the curve representing a gage of 0.1, we have

$$w = 1.155\ (d-0.1) = 1.155\ d - 0.1155.$$

For a gage of 0.1, the smallest possible diameter is 0.2—at which diameter the tube becomes a rod. If $d = 1.0$ in., $w = 1.0395$ lb. If $d = 2.0$ in., $w = 2.1945$ lb., etc. Hence, the graduated arm is swung about pin P on center C_1 until the graduation 1.0395 of the arm falls on the outer-diameter line on the chart labeled *1.0*. The point where these two graduations coincide is a point on the gage line *0.1*. Another point on this same gage line is where the graduation 2.1945 of the arm falls on the outer diameter *2.0*, still using center C_1. In like manner a series of points is plotted on each gage line and the points connected by curves. For accurate results in actual use intermediate lines and graduations are plotted as closely as the size of the chart will permit.

These same curves will give the weights per foot of tubes or rods of any other material than brass and of any other shape than circular by locating new holes C_2, C_3, C_4, etc. on the arm AB at the proper distances from the center C_1. This feature results from the fact that for any particular outer diameter and gage, the weight per foot of any material or any shape each bears a definite ratio to the weight per foot of a round brass tube of that same outer diameter and gage. This ratio for polygonal shapes, of course, assumes that the outer diameters of any particular shape are always expressed as homologous diameters. That is, if the center C_1 is

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established for hexagon diameters normal to the flat sides of same, then the diameters of hexagons must always be expressed as the normal diameter from flat to flat, etc.

The scale on the arm *AB* being a logarithmic scale, one set of values on the same may be converted to a second set bearing a constant ratio to the first by simply moving the scale along a distance corresponding to the value of the ratio. For instance, if we wish the scale to give weights *1.1* times the weights already established for round brass tubes, we would locate a new hole in the arm *AB* on the prolongation of the graduated edge at a distance from the hole C_1, in the direction of increasing weights, equal to the space on the scale between the graduations *1.0* and *1.1*. Then with the fixed pin *P* in this new hole, the weight registered on the *AB* scale by any point on the chart would be *1.1* times the weight registered by the same point with pin *P* in hole C_1.

The weight per foot of a round brass tube was derived above as

$$g \times (d - g) \times \pi \times 12 \times 0.3064.$$

The weight per foot of a hexagonal brass tube would likewise be

$$g \times \frac{\text{outer periphery} + \text{inner periphery}}{2} \times 12 \times 0.3064 =$$

$$g \times \frac{6\,d \tan 30^\circ + 6\,(d - 2g) \tan 30^\circ}{2} \times 12 \times 0.3064 = g \times$$

$$\frac{6 \tan 30^\circ}{2} \times (2d - g) \times 12 \times 0.3064 = g \times (d - g)$$

$$\times 6 \tan 30^\circ \times 12 \times 0.3064.$$

The ratio of the weight per foot of a hexagonal brass tube to that of a round brass tube of equal diameter and gage is thus seen to be

$$\frac{6 \tan 30^\circ}{\pi} = \frac{6 \times 0.57735}{3.1416} = 1.103$$

(*d* in the case of the hexagon being the outer diameter normal to two opposite flat sides). A solid hexagonal rod is, of course, only a special case of a hexagonal tube with a gage equal to one-half the outer diameter. Hence, the ratio of the unit weight of a hexagonal rod to that of a round rod of the same diameter is also 1.103. In like manner the following additional ratios are established:

$$\frac{\text{Square}}{\text{Circle}} = 1.273. \qquad \frac{\text{Octagon}}{\text{Circle}} = 1.055.$$

The unit weight of copper is assumed as 0.3215 lb. per cubic inch. The ratio of the unit weight of copper to that of brass is thus

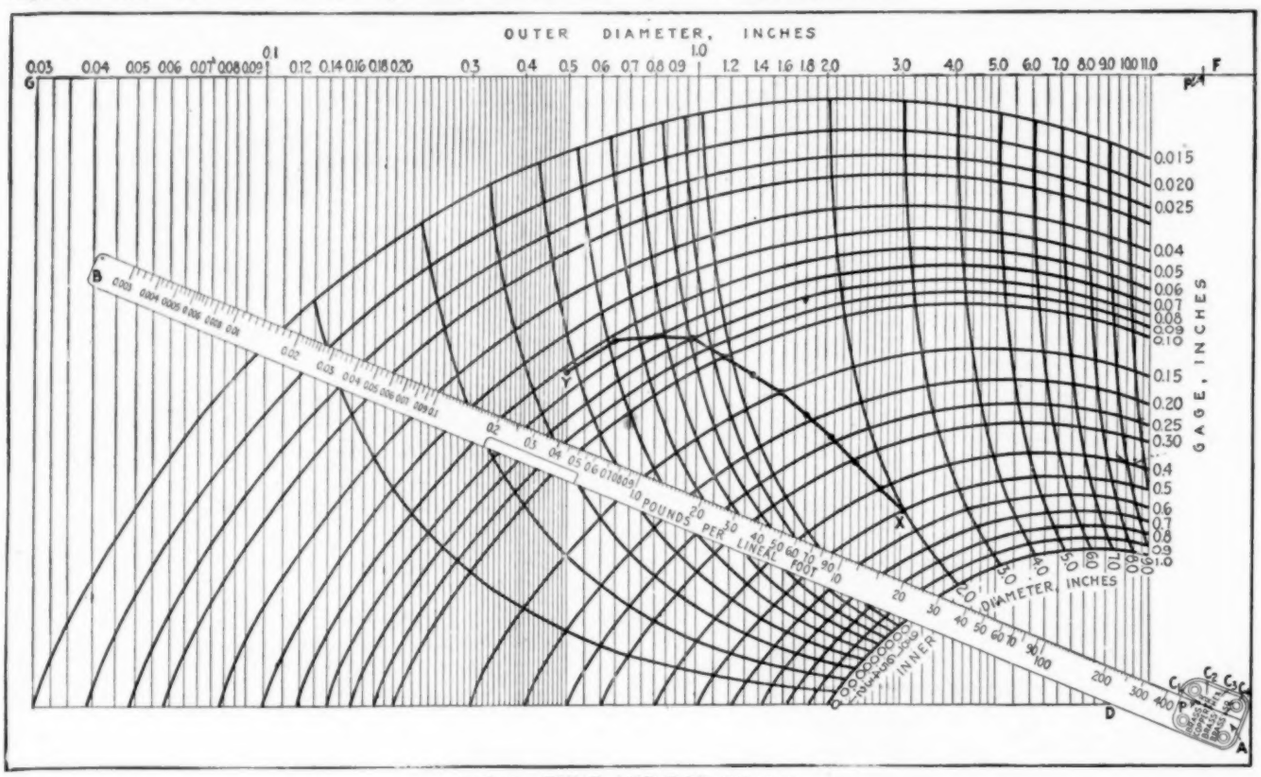


FIG. 1. TUBE AND ROD CHART

$$\frac{0.3215}{0.3064} = 1.049.$$

Therefore, the weight per running foot of a copper tube or rod of any shape should be 1.049 times the weight of a similar brass tube or rod.

The table gives the resulting relative weights, the weight of a circular brass tube or rod being taken as unity.

RATIO BETWEEN WEIGHTS OF BRASS AND COPPER RODS OR TUBES

	Brass	Copper
Round	1.000	1.049
Octagon	1.055	1.107
Hexagon	1.103	1.157
Square	1.273	1.335

The table could, of course, be extended to include additional shapes as well as tubes or rods of steel or of any other material.

After having established the center C_1 for round brass tubes and rods, the center C_2 for round copper, C_3 for hexagonal brass, and C_4 for square brass, are located on the prolongation of the graduated edge of the arm at the proper distances from C_1 in the direction of increasing weights. The distances from C_1 to C_2, C_3 and

C_4 are equal to the distances from graduation 1.000 on the edge of the arm to the graduations 1.049, 1.103 and 1.273 respectively in accordance with the above table. These various centers will then give the unit weights of both tubes and rods in the same manner as already demonstrated for brass rounds. The diameters of octagons, hexagons and squares must always be expressed as the normal diameters between opposite flat sides as the above relative weights are established on that basis.

It is apparent from the foregoing that a center may be established on the arm *AB* for any family of tubes of similar cross-sections whose cross-sectional metal areas can be expressed by the formula $Kg\ (d - g)$; K being any constant, g the gage, and d some particular dimension of the shape in question. Whatever this dimension d may be, it will always be represented on the chart by the straight rulings labeled "Outer diameters," and the ratio used in locating the distance of the new center from C_1 would be $\frac{K}{\ }$. The chart is, of course, limited to combinations of d and g, in which g is not greater than one-half d.

In the case of solid rods, a center may be established for any family of similar cross-sections; because the solid areas of such sections always vary as the squares of homologous dimensions and may be expressed as Kd^2 if the shape of the section is known—K being a constant and d some certain dimension of the section, represented on the chart by the same lines as round rod diameters. The graduated edge of the arm *AB* would always be placed on line *DE* or *FG* for rods and the ratio for locating the center in the arm *AB* would be $\frac{4K}{\pi}$.

The unit weight of any shape cross-section whatever would, of course, be the same as that of any other shape of equal cross-sectional area. Hence, the weight per foot of any shape tube or rod for which no center is provided on arm *AB* could be obtained from the chart by reading the weight of a solid square rod of the same material whose side equals the square root of the known cross-sectional area.

If extreme accuracy is desired the pin *P* should be mounted as a shifting center attached to the chart in such a manner as to permit adjustment to compensate for expansion and contraction of the chart due to atmospheric changes; and several arcs representing certain definite unit weights should be shown across the face of the chart from some particular center, as C_1, for adjustment purposes.

On a logarithmic scale such as that on arm *AB* the distance between graduations *0.9* and *1.0*, for instance, is of course, the same as that between *9.0* and *10.0* or between *90* and *100;* and any two readings on the scale which are that same distance apart differ in the same ratio—that is, the smaller is 90 per cent of the larger; or in other words, the smaller represents a 10 per cent. reduction of the larger. The cross-sectional area of a tube or rod varies directly with its weight per foot and hence a 10 per cent reduction in weight per foot represents a like reduction in the metal area of the cross-section. Therefore, considering, as an illustration, any two arcs swung from the center *P* and spaced a distance apart equal to the space between graduations *8* and *10* on the arm *AB*, a tube represented by any point on the arc furthest from *P* would have a metal cross-section 20 per cent less than any tube represented by any point on the arc nearest *P*, and the intersection of these two arcs with the line *DE* would indicate the diameters of two solid rods—the metal area of the smaller of which would represent a reduction of 20 per cent from that of the larger.

Hence, the arm *AB* may be replaced by an arm *MN*, Fig. 2, on which is mounted a sliding reduction scale *S* for the planning and investigation of reductions of metal area in drawing or rolling operations.

The distance from *0* to *10* on the scale *S* represents a reduction of 10 per cent and is equal to the distance from *9* to *10* on scale *AB*. Likewise, the distances on scale *S* from *0* to *20*, *30*, *40* and *50* represent those percentages of reduction and are equal to the distances on scale *AB* between graduation *10* and graduations *8*, *7*, *6* and *5* respectively.

Scale *S* is mounted on arm *MN* so as to slide on same and the holes C_1, C_2, C_3, and C_4 in the arm are all the continuation of the graduated edge of scale *S*.

The distances between the holes C_1, C_3 and C_4 of arm *MN* are the same as those between the similarly lettered

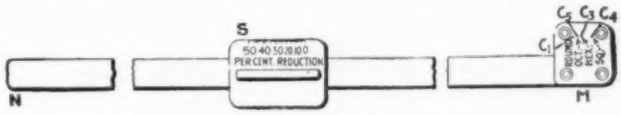


FIG. 2. REDUCTION SCALE ARM

holes of scale *AB*, while the distance from C_1 to C_2 is equal to the distance between graduations *1.000* and *1.055* of scale *AB* so that if center C_1 is used for round tubes or rods, C_2, C_3 and C_4 represent the corresponding centers for octagon, hexagon and square shapes respectively. If the arm *MN* and scale *S* are to be used for a series of reductions in which no change of shape is to occur, it is, of course, immaterial which of the four holes in the arm is placed on the pin *P*; but if a tube or rod is to be changed from a round shape to hexagonal shape for instance, the reduction percentage would be arrived at as follows: Place the arm *MN* on the chart with the pin *P* in hole C_1; slide the scale *S* along the arm and swing the arm on the pin *P* until *0* of the scale *S* is on that point of the chart representing the initial diameter and gage of the round tube or rod. Leaving scale *S* in this position on the arm *MN*, slip the hole C_3 over the pin *P*. If the arm *MN* is then swung about the center *P*, any point of the chart on the arc described by graduation *20*, for instance, of scale *S* would represent a hexagonal tube or rod whose metal area is 20 per cent less than that of the initial circular tube or rod.

Let us suppose that the metal area of the tube or rod is then to be further reduced 10 per cent and the shape changed to a square. With the hole C_3 still on pin *P* slide the scale *S* on arm *MN* until graduation *0* of the scale comes to the point representing the hexagonal tube or rod. With the scale in this position on arm *MN*, if the hole C_4 is placed on the pin *P* any point of the chart on the arc described by graduation *10* would give us the result sought; that point being selected which gives us the desired gage or outer diameter or inner diameter as the case may be.

Arm *MN* and scale *S* may, of course, be similarly used to investigate the reduction percentage necessary in drawing from any known or proposed shape, diameter and gage to any other.

The sliding scale *S* may be mounted on the arm *AB* if desired, thus combining weight scale and reduction scale. If any particular reduction percentage is used quite frequently one whole edge of the arm *MN* or the unused

edge of arm *AB* can be divided into equal spaces representing that percentage—or one edge of *MN* could be divided to represent one percentage and the other edge a second percentage and the reverse side of the arms could be used for still more percentages. The centers C_1, C_2, C_3 and C_4, however, should always be in line with the graduated edges for which they are used.

After the gage curves are plotted on the chart, the corresponding inner diameter curves are readily located from the fact that the curve for any particular inner diameter passes through the intersections of the various gage curves with those outer-diameter lines, representing outer diameters equal to the known inner diameter plus twice the gage.

Value of Inner Diameter Curves

These inner-diameter curves are useful in planning a series of tube reductions because of the fact that such reductions should be planned, if possible, so that each successive inner diameter will be smaller than the previous inner diameter by not less than a certain minimum difference in order to allow the plug for forming the new inner diameter to be slipped freely inside of the tube before reduction.

These curves will also indicate the necessity of an expansion of inner diameter under certain circumstances and will enable the point at which such expansion is to be made, to be intelligently planned in advance. In some cases it might be preferable to reduce the inner diameter a reasonable amount in each draw even if this treatment necessitates an expansion at some point in the process; rather than to attempt a series of draws, each one of which might reduce the inner diameter by such minute steps as to lead to excessive trouble in inserting the inner plugs.

The line *xy* on the chart pictures a typical tube reduction from an outer diameter of 3.0 in. and gage of $\frac{1}{4}$ in. to an outer diameter of $\frac{1}{2}$ in. and gage of $\frac{1}{16}$ in. with no change in shape. The line shown represents a 30 per cent reduction at each draw except the last and a constant inner diameter reduction at each draw.

Each dot represents a step in the process and each straight line joining two successive dots represents a draw. The outer and inner diameters at each of these dots indicate directly the die and plug to be used in the preceding draw. The dots in practice would be shifted slightly from the rigid course shown in order to use certain standard dies and plugs and minimize the number of special tools.

The Mechanics of the Future

By Joseph T. Taudvin

Continuing the line of thought that has been under discussion for some time in the *American Machinist*, regarding the merits of various apprentice systems, I would like to know what our American-born boys are doing in regard to the machinist trade.

If one would stop a moment and look over the boys and young men who predominate in our apprentice and technical high schools and the various evening trade schools, he will be surprised to note that over 50 per cent. are foreign born.

Personally, I have no fault to find with these boys. They are our coming mechanics, but I would like to see more native-born boys entering the trade. The day is fast approaching when the personnel in the machinist trade is going to be cast along more distinct lines than it is today. Our colleges and technical schools are turning out so many "M. E.'s" that the trade will not be able to absorb them.

It means two distinct classes; the superintendents and foremen will be technically trained men and the men at the bench and machine will be classed as "operators." This will not necessarily mean low wages for the men, but it will mean higher salaries for superintendents and foremen in proportion to what they are now receiving, and it will also make it more difficult for the workman to work up to the higher positions, because he will not be equipped with the necessary technical education.

The young man who considers entering the field of mechanics should seriously consider this question, unless he would be content to remain an operator or hold a minor position.

One has only to glance over the "Want Ads" in the *American Machinist* and other mechanical papers to note the qualifications required of the candidates for various positions. You will note, especially in advertisements for superintendents and general foremen, that invariably it will say, "Technical education necessary," "Must be a technical graduate," etc.

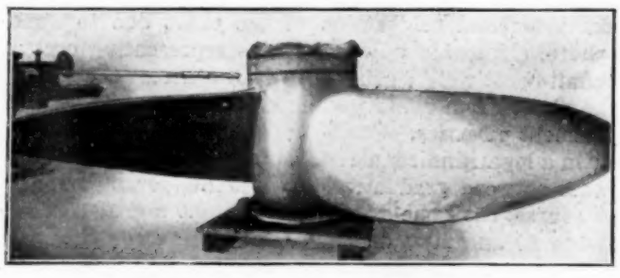
This simply shows the trend of the times and it would be well for any young man to be prepared if he wants to qualify for a good paying job in the mechanical field.

Special Work on Manganese Bronze Propellers

By Geo. F. Paul

One of the principal difficulties encountered in casting propellers from manganese bronze is the excessive shrinkage of the metal. To obviate the trouble it has been found best to allow considerable excess metal which it is necessary to cut away as a part of the machining operations.

To do this work the unit is mounted on the floor in such a way that it can be turned upon its axis and a series of holes drilled to encircle the hub. These holes run together a short distance from the outside, and, consequently, the final removal of the head can be easily accomplished wth hammer and cold chisel. The drill is mounted in an extension socket, which is operated from a radial drilling machine or from a turret lathe or other convenient tool.



CUTTING OFF HUB OF PROPELLER

The propeller shown in the accompanying illustration is 17½ ft. in diameter. The casting as it comes from the sand weighs 31,000 lb., but is reduced to 28,000 lb. when the propeller is finished ready for installation.

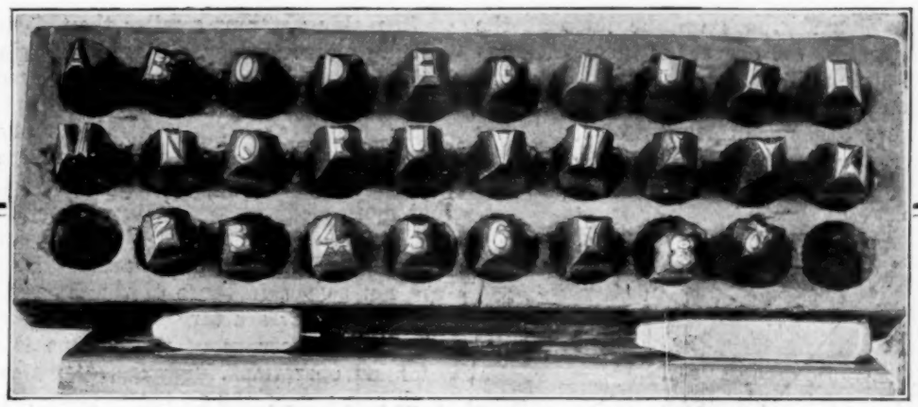


FIG. 1. SET OF PUNCHES FOR LETTERS AND FIGURES

How Hand-Cut Steel Stamps Are Made

By S. A. HAND
Associate Editor *American Machinist*

Many mechanics suppose that all steel stamps are made by forcing the annealed end of the blank into a hardened block containing an impression the reverse of the stamp to be made. Such a process may be employed in making the cheapest grades of stamps. However, in making stamps of the better grade, known as hand-cut, much skillful hand work is necessary, and the tools and methods used are herein described.

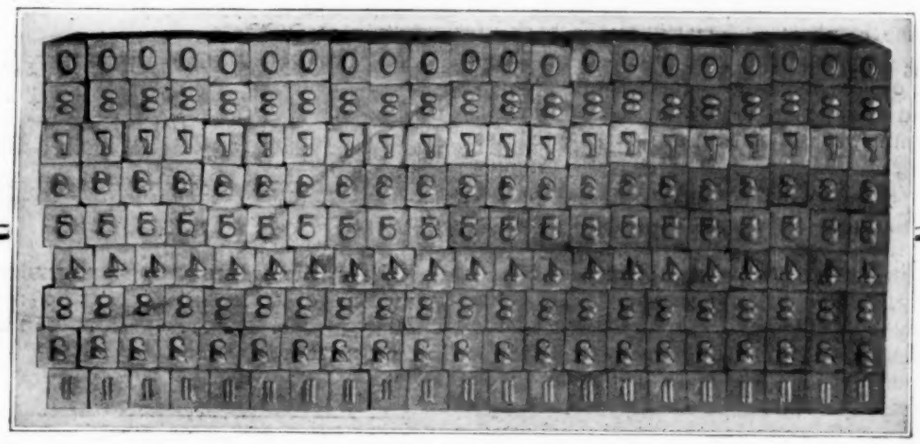


FIG. 2. FIGURE STAMPS AFTER PUNCHING

SO-CALLED hand-cut steel stamps for stamping letters or figures on metal are made of the best quality of crucible steel. The blanks are cut off in multiple in a power hacksaw which leaves the ends square enough and smooth enough so that no further finishing is necessary until after the next two operations. The next step is to scribe lines on one end of the blank with a pair of hermaphrodites to be used in positioning the punch for forming that part of the character which is below the surface. A series of such punches for making a complete set of letters and figures is illustrated in Fig. 1, while in Fig. 2 may be seen several sets of figures that have been punched.

The evolution of making a stamp for the capital letter E is shown in Fig. 3 and the following explanation should give the reader an idea of the processes necessary to make a complete stamp. *A* shows the blank after the lines have been scribed. In this condition several blanks are placed on end in a vise of the type used on planing machines but so massive in construction as to practically absorb the shocks from hard blows with a heavy hammer. Here a punch having the contour of the sunken part of the character to be made is held on top of one of the blanks and located by the scribed lines before referred to. It is then struck several blows with a very heavy hand hammer, the number of the blows depending on the depth of depression wanted.

Referring to Fig. 3, *B* shows the appearance of the blank after being punched. The operation of punching throws up quite a heavy burr which is removed by hand filing, and after this has been done, the sides are ground to a long bevel as illustrated at *C*. This is done on a wet grinding machine, the blank being held and guided entirely by hand, and while performed with great rapidity, requires considerable skill; otherwise too much stock may be ground off to allow for the proper formation of the character in the subsequent operations.

The next step is to file a short bevel on three sides

as shown at *D*. This sharpens up the lines at the top, front and bottom of the character, their thickness depending on the style of the character and the nature of the material on which it is to be used. It will be readily seen, however, that the thickness of these lines is entirely under the control of the man handling

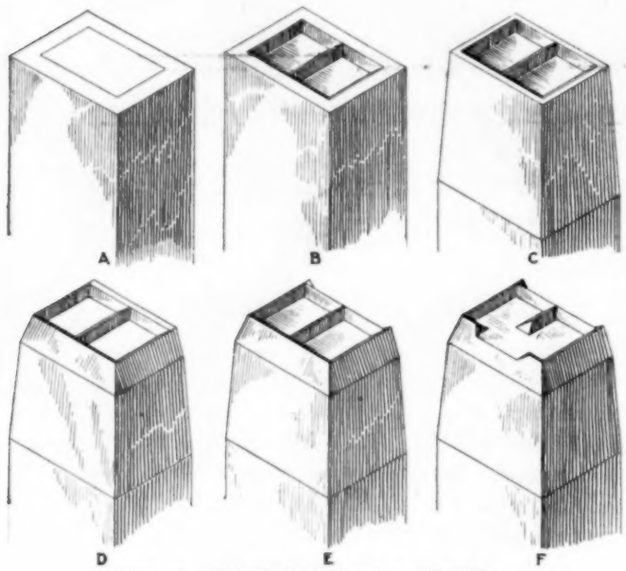


FIG. 3. EVOLUTION OF A STAMP

the file. Then the blank is so beveled at the back of the character as to bring the rear line to the same thickness as the others and also to form the two short lines that extend to the rear. The result of this is shown at *E*. Finally, the lines that are not wanted are cut away, leaving the character completely formed, as may be seen at *F*. It will be readily seen that this letter could easily have been made into a capital F by cutting off the lower short vertical line at the front of the letter and part of the bottom line.

If, after filing, it should be necessary to sharpen up any of the inside corners or to do any work on the interior of the character, a hand graver is used.

The maker's name and trade mark are stamped on the side of the shank under a hand-operated drop press.

For hardening, the stamps are heated in a gas-fired muffle furnace and quenched in water. The temper is then drawn to a straw color on an open plate heated by bunsen burners and the stamps again quenched in water.

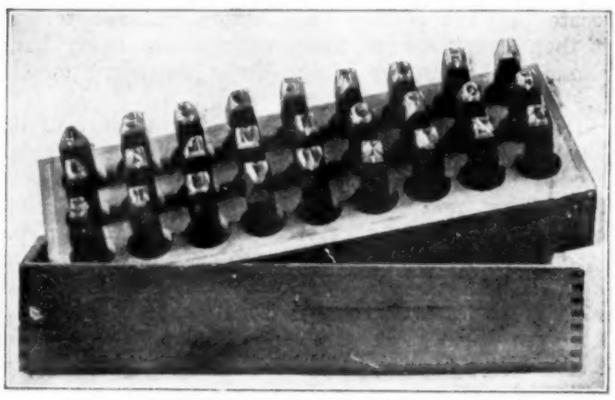


FIG. 4. ALPHABET STAMPS READY FOR USE

In making stamps smaller than $\frac{3}{16}$ in. all filing and cutting with a graver, a magnifying glass such as used by watchmakers, is constantly employed.

When in use, stamps often have parts of their character lines broken and the makers say that this may be the result of not holding the face of the stamp flat on the work when striking it with the hammer but more often by trying to deepen the impression in the work by striking the stamp several blows in succession and that if the character lines of the stamp are not seated in those of the impression previous to each blow they are very likely to be fractured.

The manufacture of the stamps is wholly a series of hand operations, each one of which requires great skill and good sight on the part of the workman.

The description of the processes as outlined in this article was obtained during a visit to the plant of the Hoggson & Pettis Manufacturing Co., New Haven, Conn.

A Little Question of Trigonometry

BY H. V. REED

A much simpler solution of the problem on page 713, Vol. 51, is as follows:

Referring to the figures, it will be evident that

$$QR = b$$
$$NQ = RS = a$$
$$OS = MO = C$$
$$NO = b - c$$

In triangle *NOQ*,

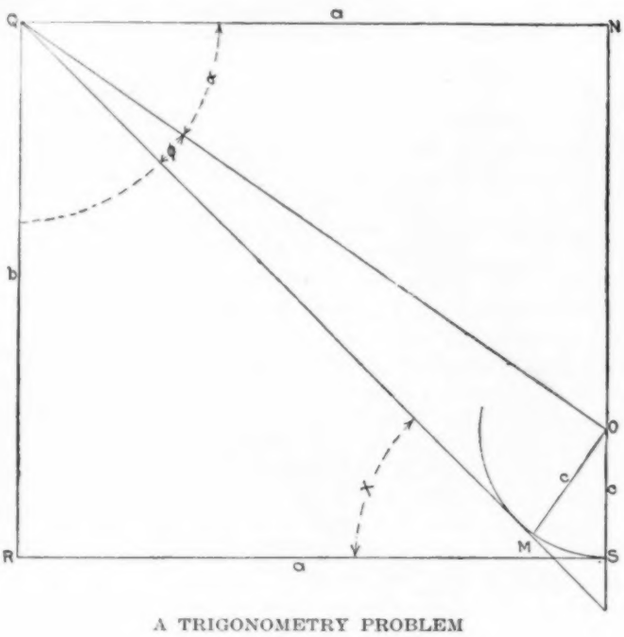
$$QO = \sqrt{a^2 + (b - c^2)}$$

$$\sin a = \frac{NO}{QO} = \frac{b - c}{\sqrt{a^2 + (b - c^2)}}$$

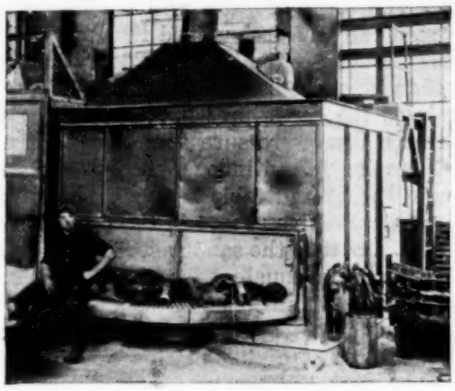
$$\text{Also, } \sin \phi = \frac{MO}{QO} = \frac{c}{\sqrt{a^2 + (b - c^2)}}$$

$$X = a + \phi$$

[The editor takes this opportunity to thank the numerous other contributors who sent in solutions similar to Mr. Reed's. His is published because it arrived first.]



A TRIGONOMETRY PROBLEM



Application of Sandblast to General Foundry Work–II

By H. D. GATES

Ample protection for operators should stand foremost in the minds of the designers of sandblast equipment. This is accomplished to some extent by providing mechanical means of handling material, with accompanying savings in labor cost and time.

THE trend toward rooms that entirely remove the operator from the sandblast inclosure has developed devices of different types to meet every demand. These rooms consist essentially of a sight screen through which the operator may see his work, while below are openings closed by sectional flexible curtains, through which the operator directs the nozzle on the work to be cleaned. An exhaust is provided to remove the dust, so as to permit free observation of the work. Where long or heavy work is to be cleaned, the equipment is arranged as shown in Fig. 9. In this way pieces 20 to 30 ft. long are readily cleaned in an enclosure but little more than half their length. When the output of the foundry does not include work larger than the area of one-half of a 90-in. diameter circular table, a semicircular cabinet, Fig. 10, with a turntable mounted on dust-proof ball bearings offers an ideal equipment. Installations of this kind are easily equipped with abrasive separators, dust exhaust, and storage bins.

All the installations described provide for the sandblast to be located at the floor level. Where floor space is at a premium, the sandblast can be located in a concrete hopper below the floor and the abrasive for re-use passed to the separator by gravity. This type of installation eliminates the use of the elevator and conveyor. General utility and ease of access has recommended the floor-level type where floor space will permit.

While the above installations with the hose machine will clean any and every character of work possible with any other type of sandblast, the fact must not be lost sight of that economy of cleaning with this device decreases as the size of the pieces become smaller, requiring added time and labor for individual handling.

Mechanical Handling

For the plant that has a tonnage of small work sufficient to warrant special equipment, the barrel sandblast, or the rotary-table sandblast, or both in combination, will be found time and money savers and are of further advantage in that their operation is entirely hygienic and relieves the operator from any contact with the dust-laden air.

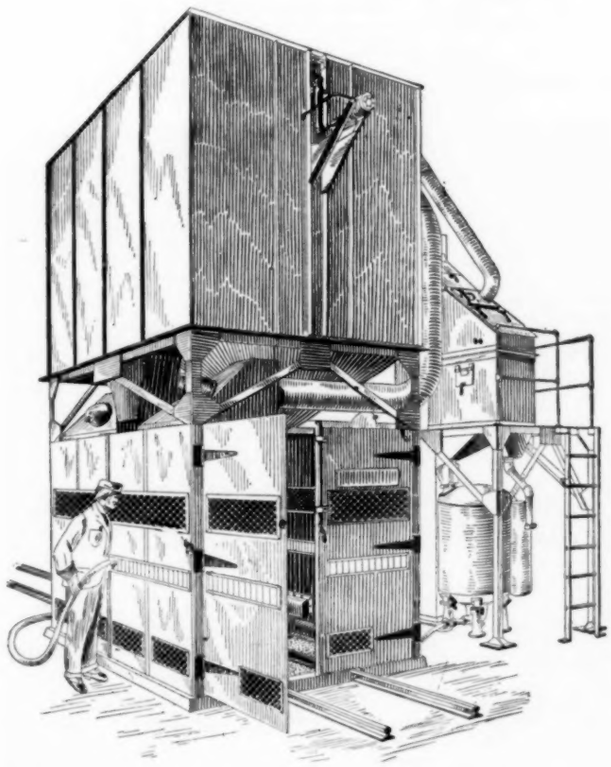


FIG. 9. A SANDBLAST INSTALLATION SUITABLE FOR LONG AND HEAVY WORK IN WHICH THE OPERATOR WORKS OUTSIDE THE INCLOSURE

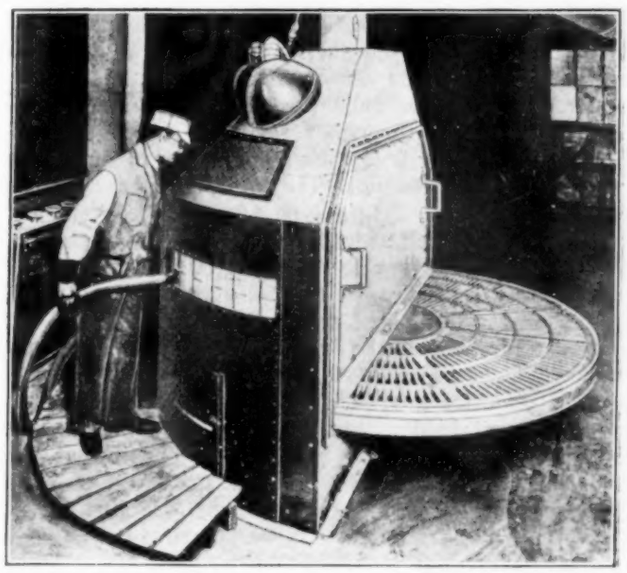


FIG. 10. A REVOLVING TABLE SANDBLAST CABINET DESIGNED FOR CLEANING MEDIUM-SIZE CASTINGS

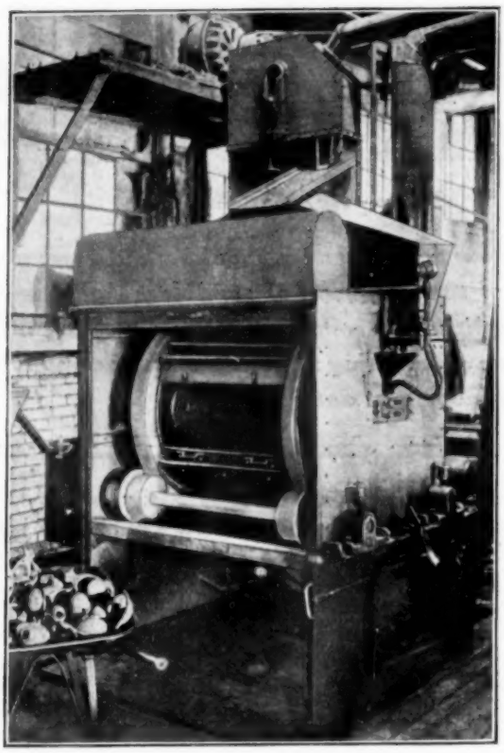


FIG. 11. THE REVOLVING-BARREL OR DRUM TYPE OF SANDBLAST MACHINE

The barrel sandblast, Fig. 11, consists of a slowly revolving drum, a detail of no little importance, necessary so as not to damage square corners or ornamentations, within a steel case, into which are introduced sandblast nozzles that blast the pieces as they are turned over. The construction of the drum is such that in turning every surface comes in contact with the sandblast. These units are self-contained, the spent abrasive falling through perforations in the drum and thence to a hopper, from which it is raised by a elevator, cleaned and screened, and delivered by gravity to the nozzles for re-use. In this type of machine the interior of the drum is entirely unobstructed and it will receive pieces up to the limit of the door opening size. Machines of the suction type have a manifold running through the center with a series of nozzles, and as the abrasive falls through the drum perforations it is passed through a series of screens to feed boxes, from where it is raised by suction to the nozzle and, in combination with the air, projected onto the work. Machines of this type are more efficient for smaller pieces, such as valve bodies, pipe fittings, etc., from which cores are to be removed.

For work of a fragile nature, such as stove plate, precision work, or pieces whose shape and size will not permit rolling within the drum, the automatic revolving-table sandblast, Fig. 12, is of greatest utility.

In this device a grated top table *A* is half exposed and half contained within a steel case *B*, wherein the blasting operation takes place. The opening at the front of the case to permit free passage of the castings is closed by multiple, flexible, sectional curtains *C* that retain the flying abrasive and dust during the passage of the work. The pieces are loaded onto the exposed half of the table by the operator, and as they emerge from the blasting chamber they are turned, as necessary, to bring all parts under the blasting action, until thoroughly cleaned, when they are removed and new work loaded. This type of table will handle material as fast as a man can load and unload it.

The cleaning is done by multiple nozzles which oscillate so that the pieces are blasted from all angles. The blast action is of the direct-pressure type, the nozzles being fed from a direct-pressure hose machine beside the table. Operation is continuous, the spent abrasive falling through the grated table top, being carried by an elevator to the abrasive separator *D* that cleans the abrasive and delivers it to the sandblast *E* for reloading.

The above devices are equally adaptable for the cleaning of brass and aluminum, as well as iron and steel, and are recommended to brass foundries of sufficient tonnage to warrant cost of installation and operation.

For the Small Foundry

There is, however, as much advantage in the cleaning of brass or aluminum castings with the sandblast as in the ferrous metals, and when cleaned on the gates the result is economy of time and labor and clean scrap. For the small jobbing brass foundry a unit such as shown in Fig. 13 meets the requirements from every point of view. The initial cost is not large, floor space required is small and, being of the suction type, it is self-contained and continuous feeding, as well as hygienic, the operator not being exposed to the dust-laden air.

These cabinets, which are made in various types and sizes, are equipped with either stationary or flexible nozzles. In larger sizes the nozzle is supported by an arm adjustable in all directions and reaching every part of the cabinet. With the stationary nozzle the pieces are turned under the blasting stream, while in the larger type with the adjustable arm larger and heavier pieces can be cleaned, the nozzle being moved as required, instead of turning the work.

Regardless of the type of equipment used, adequate means of ventilation for the removal of dust must be provided. This is accomplished by exhaust fans of

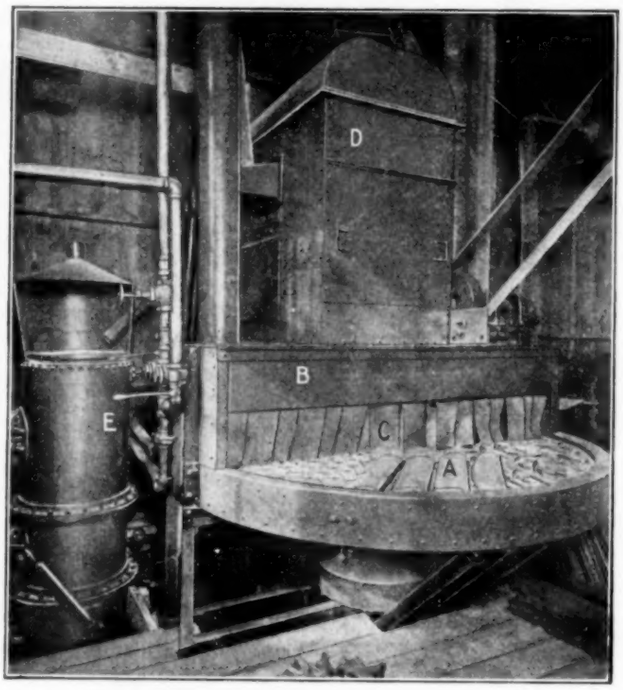


FIG. 12. A REVOLVING-TABLE SANDBLAST SUITABLE FOR SMALL AND FRAGILE WORK

proper capacity. The disposal of the dust is a point which demands serious consideration. If the plant is isolated, the dust can be discharged into the open, but where harmful effect might result either to the shop or the neighborhood it is advisable to separate the dust from the air. This can be efficiently done by either the common centrifugal separator modified to meet surrounding conditions, which will suppress about 90 to 95 per cent. of the dust, or the cloth screen type of arrester, which suppresses all the dust.

Kinds of Abrasives

Various kinds of sand are now mined and graded for sandblast use. Sands which are hard, sharp, clean, with the least disintegration, not only show longest life and highest abrasive quality, but create less dust. River or bank sands are rarely economical even at lowest first cost. Ocean sands are quite satisfactory, but undoubtedly the white silica sands, where available, are most desirable. In fact, by their hardness and uniformity they undoubtedly prove most economical at a higher first cost.

Metal abrasives in the form of chilled shot, crushed steel, etc., are produced by different manufacturers, each making claims for their superiority. Of the life of the metal abrasives over sand there can be no question, and this will range from 20 to 60 times. Disintegration is at the minimum and almost no dust is created from the metal abrasive itself.

In this connection, however, the much higher first cost demands an absolutely tight inclosure throughout, as any daily loss, even though small, will soon wipe out the saving in efficiency. The selection of sand or metal abrasive will present several features for consideration. If the work to be cleaned is reasonably free from sand, considerable advantage in operating conditions will be found by the use of metal abrasives, owing to their creating practically no dust by their own disintegration. If the work is cored or carries a large volume of sand, the advantage from the metal abrasives in this connection will obviously be greatly decreased, and the dust created by the disintegration of the blasting sand itself will not materially increase the dust volume arising from the castings.

Where pieces are to be galvanized or plated, some complaint has been registered against the use of metal abrasives, in that the fine metallic dust adhering to the pieces prevent satisfactory results in plating. For general foundry output, however, the character of the work itself, with the delivered cost of the various abrasive, will readily determine the economy of one over the other.

All modern sandblast devices can use, with equal facility, either sand or the various metal abrasives.

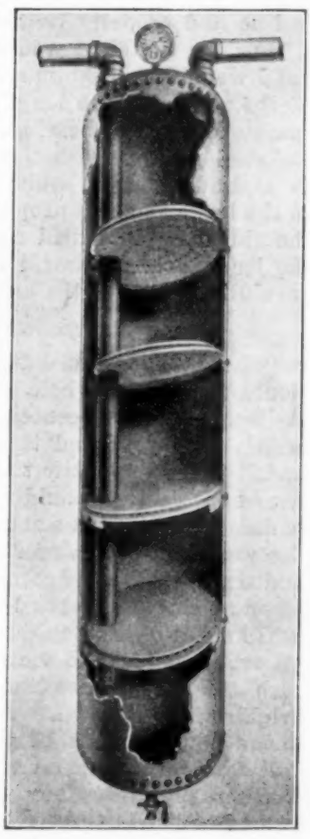


FIG. 14. TYPE OF MOISTURE SEPARATOR RECOMMENDED BY THE UNITED STATES EMERGENCY FLEET CORPORATION

Dry Air an Important Detail

One of the frequent causes of unsatisfactory operation of the sandblast is the presence of moisture in the air line, which, if in sufficient volume to make the sand at all plastic, will naturally prevent an even, steady flow of the abrasive. When metal abrasives are used, the mixture of moisture with the fine metallic dust frequently tends to rust the abrasive into a solid mass. Any device that will eliminate the moisture will be of a decided advantage not only in connection with the sandblast but with all pneumatic tools. The United States Emergency Fleet Corporation in a recently issued Standard Practice Bulletin describes a satisfactory device for this purpose, and from which we quote:

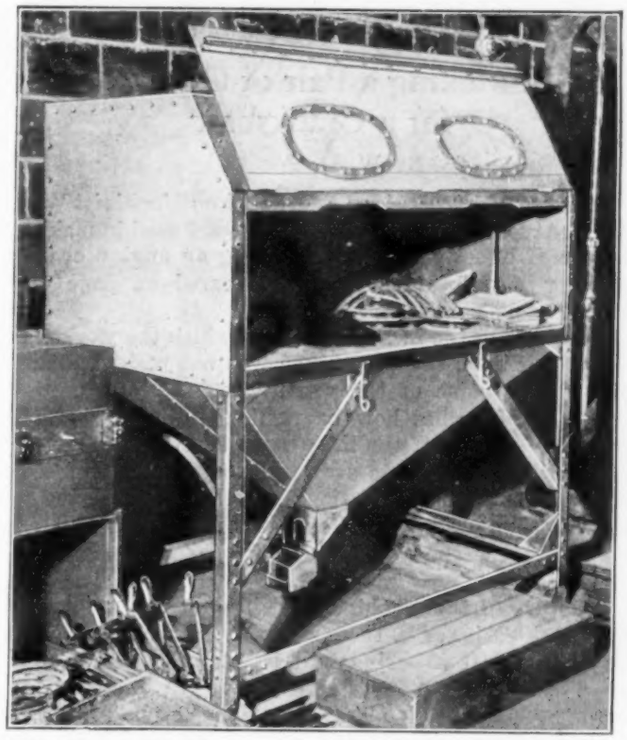


FIG. 13. A SMALL SELF-CONTAINED SANDBLAST FOR SMALL FOUNDRIES AND SUITABLE FOR CLEANING BRASS, IRON AND STEEL CASTINGS, FORGINGS AND STAMPINGS

"It is the object of this communication to call attention to the importance of a second step which should include provision for effectually separating and draining the water of condensation from the piping system.

"The water cannot be properly taken care of merely by placing drain cocks on low points in the ordinary piping system, but should be removed by special separating tanks or chambers located at these points and near the distributing manifolds.

"The separating chambers should be large enough to lower the velocity of the air to a point where entrained water or dirt will not be carried through with the air current, and should be fitted with bafflers or connections which will change the direction of flow, so as to precipitate the entrained matter."

An illustration (Fig. 14) of this device is shown, and its installation on the air line near the various tools

will assure freedom from moisture troubles and will save in lost time their first cost in a comparatively short period.

While the material advantages of sandblasting are few in number, yet their importance is of no small consequence. Sandblasting removes the entire destructive scale from the casting which on the contrary is intensified by rumbling and cleans castings that, due to their fragile nature, cannot be rumbled. The appearance of castings is very much improved, and whether castings are to be galvanized, painted, plated or machined, the surface produced by thorough sandblasting assures perfect results with minimum costs.

Cost of Making a Pair of Offset Centers for a Crankshaft

By W. D. Forbes

On page 605, Vol. 51, of the *American Machinist* Wesley McArdell comments on the methods I used in making a pair of offset centers for turning an engine crankshaft, a description of which appeared on page 300 of the same volume.

Considering the awkward way in which the work was done, he thinks the time taken was not bad. He considers that some of the work was done in a unique way, and describes how he would do it, but fails to give an estimate of the time required.

If Mr. McArdell has ever made such a pair of centers of about the same size, I would be interested to see his time cards; or, if he never made them, his estimate of the time that should be taken would be of equal interest.

The use of the machines specified in my article for the work assigned to them seems to me to be perfectly legitimate. If a boring mill is evidently well suited to a certain job why not do that job on a boring mill? Almost all machine-shop work can be done on a lathe; yet we have planing, milling, and grinding machines, etc.

I maintain that the work as described by me is simpler than Mr. McArdell's methods. The main point is to accurately locate the holes for the crankshaft and centers a given distance apart and still keep them parallel. This measurement is not one where tenths of thousands count and the screw in either boring mill or milling machine would be equally serviceable for the spacing.

Leaves Plugs Without Centers

The way in which Mr. McArdell would make the tool-steel plugs would leave them without centers. Besides, working back of a shoulder as he describes demands very close calipering to make a fit, and if, after cutting the piece off, it is found to be not just right, it would be more difficult to correct it because of there being no center in one end. Most machinists will admit that to leave centers in a lathe job is the usual practice.

Mr. McArdell also advocates holding the bar in a four-jawed chuck. I have no doubt that on mature reflection, he would admit a three-jawed chuck would hold it as well as a four-jawed one.

A few days after my article appeared in the *American Machinist*, one of the best toolmakers in my town came to see me and he asserted that the 13 hours taken for the work was about four hours too much. I tried to get him to write his way of saving this time, but, with the diffidence that so often deters an otherwise competent man from expressing himself and thus deprives the readers of technical magazines of many valuable suggestions, he declined. I could not get him to understand that it was ideas—not words—that the *American Machinist* required; so long as the former were made clear the editors would look after the wording.

As I could not induce him to write, I am sending you the details of his method. He said: "I would cut the bar to the length of the two pieces; prick-punch one side for a witness mark; clamp it to an angle plate on the planing machine with the prick-punched side to the angle plate and finish one edge only. Thus I would save most of the planing work.

Boring the Holes

"After parting the piece in the middle I would set up the two slabs on the horizontal boring mill with the prick-punched faces together, the pieces resting upon the planed edges on the table of the machine. With a starting drill in a taper socket fitted to the spindle of the machine I would start the center of the large hole; then put through the large drill and finish the hole to exact size with the boring bar.

"Shifting the table over the proper amount to give the required distance between centers, I would again use the starting drill, but would make this hole at least 1¼ in. in diameter, as I like something good and stocky if possible and there is no reason for a small diameter here. I would just clean this hole with the boring cutter, paying no attention to size. All I would want is a true hole. This would give me the four holes in line and properly located.

"For the centers I would cut each piece to length, but I would not make it more than half the thickness of the slab plus the length of the head, as I see no reason for greater bearing. I would center these two tool-steel pieces; finish them all over; and hold them in a draw-in chuck while enlarging the countersink in the large end to a proper size and depth. While in the chuck I would drill a small hole almost through the length, then I would harden the large ends and carefully clean out the centers.

Provisions for Oiling

"When I had forced the centers into the webs I would drill a small hole down through the webs and the shanks of the centers, and use these holes for oiling. I have found this dodge to work very well and it takes very little time to do the drilling. Only one of the centers would require oil, but it would pay to finish both in this manner, for, if one begins to cut, the webs can be changed or the centers knocked out and transposed. The corners and edges I would touch up on an emery wheel and save most of the vise work.

"I know the job would not look as nice as if planed all over and I like to see jigs and tools look nice, but such things as these will not be better handled if bright and I know I would be at least four hours ahead of your time of 13 hours."

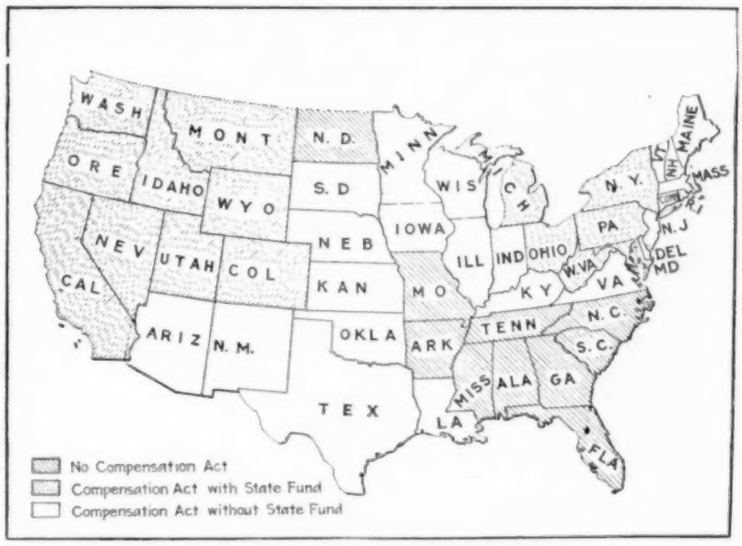
Referring once more to Mr. McArdell's criticism: The soft plug he refers to is well known to all mechanics but it has to be made, although a piece of rod brass cut off at little cost might answer very well. I have found, however, in any position like the one in question the slotted relief saves trouble.

A Workman's Compensation Digest

BY CHESLA C. SHERLOCK

We have published several articles from the pen of Mr. Sherlock dealing with the technical features of the workman's compensation acts. In this digest of the practice in those states which have compensation acts, the author sums up the available information and presents it in tabular form for the benefit of the man who hasn't the time to dig it out for himself.

TO really understand the workmen's compensation acts is practically impossible, unless a digest is made of the acts and a comparison made between them. This is especially true of the large employer who does business in several different states. Without the aid of a digest he will never know so very much about the inner working points of the system. To this end, the accompanying digest has been prepared. It was intended to give the employer a handy working reference of the more important points arising under the compensation acts, all touching intimately upon the question of the employer's liability. Other matters, of a more technical nature, have been considered from time to time in the past. The accompanying map will give a fairly accurate outline of the spread of the compensation idea over continental United States. Only ten states remain without a compensation act of some nature, and the chances are that by the time this appears in print one or two, possibly more of them, may have changed their character. This progress has all been made within the last nine or ten years.



THE GROWTH OF THE COMPENSATION IDEA

While the principles underlying the workmen's compensation acts are the same everywhere, the indifference and carelessness with which some of these laws have been framed and enacted has resulted in a wide difference of liability being recognized in different states. The first statute adopted in the United States, that of New York, was closely patterned after the English act of 1906.

The other states to follow New York's example borrowed their acts largely from New York, adding amendments as it suited their whims. The result soon became a mixture of the original English act and a number of fantastic amendments which so completely changed the character of the law in different localities as to work hardship upon the workman it sought to protect.

The industrial conditions, speaking in a broad sense, are practically the same the country over. At any rate, the value of a workman's life or limb should not be higher in one community than another, if you want to look at the matter in an impartial light. Yet, many workmen would be vastly better off if they were injured in New York, for instance, than in Kansas. There is a difference, in liability, between those states of all the way from 16⅔ to 41⅔ per cent. in the employer's liability for accidents occurring in those states.

The difference, however, does not rest entirely with the workman who happens to be injured; it rests likewise with the employer—especially the employer who happens to transact business in more than one state.

The misunderstandings which arise in the compensation field among employers are very largely due to a misunderstanding as to this liability. The statutes, unfortunately, are not the same everywhere, and this only emphasizes the need of every employer to acquaint himself with his measure of liability wherever he may happen to be doing business. Practically every state has what is called a "waiting period"; that is, the length of time which must elapse after an accident before the workman can collect compensation from his employer. This waiting period varies in the respective jurisdictions, but its average length is two weeks. See Table I.

The purpose of the waiting period is two-fold. First, it is to give the employer an opportunity to investigate the accident and satisfy himself as to the genuineness of the injured workman's injury, and to discourage malingering on the part of said workman. The second purpose of the waiting period is to give the employer a leeway of time before compensation liability attaches so that he will not be hit so hard financially. The law requires the employer, after the accident, to furnish immediate medical, surgical and hospital relief. It is thought that this burden, together with immediate payments of compensation would be unequal. Since the employer and workman are to share the loss occasioned by the accident, it was deemed equitable that the workman should wait for a time for his compensation.

It is well for employers to note a point here that will be considerably to their advantage. Unless the workman is still incapacitated at the end of the waiting period, and unable to return to work, or still suffers an impairment of his earning capacity, no compensation liability except the medical and hospital attention attaches to the employer.

This, of course, is not true in a case where a workman suffers what is known as a "schedule injury," which may be better illustrated as saying a loss of a finger, arm, hand, leg, sight of one or both eyes, or any other form of permanent disability. These injuries are to be compensated at the amount scheduled in the statute regardless of the time elapsing before the workman can return to his work, the law *presuming* that he has been impaired in his earning capacity to the extent mentioned in the schedule.

TABLE I. WAITING PERIOD

	Weeks
Arizona	2
California	2
Colorado	3
Connecticut	10 days
Illinois	1
Indiana	2
Iowa (absorbed)	2
Kansas	2
Louisiana	1
Maine	2
Maryland	2
Massachusetts	10 days
Michigan	2
Minnesota	1
Montana	2
Nebraska	2
Nevada	2
New Hampshire	2
New Jersey	2
New York	2
Ohio	1
Oklahoma	2
Ontario	1
Oregon	None
Pennsylvania	2
Rhode Island	2
South Dakota	2
Texas	1
Vermont	2
Washington	None
West Virginia	1
Wisconsin	1
Wyoming	10 days

But in an ordinary case, if a workman is incapacitated only for the waiting period or less, no compensation is due, although the writer has known employers who paid compensation amounting to several hundred dollars in the course of a year which they were not legally liable to pay.

Beginning of the Waiting Period

Contrary to the general opinion, the waiting period does not necessarily commence to run at the same time the accident occurs, although it may commence to run at that time, and, in fact, generally does. The waiting period technically commences to run only when the workman is incapacitated for work and then the employer's liability for the payment of compensation does not commence to run until after the waiting period has expired.

Let us take a specific case by way of example. Let us suppose that a workman is injured in New Jersey. He receives a fall while engaged in his employer's business which does not at the time incapacitate him from work, but a week later, by reason of his injury, he is forced to quit work.

At this point the waiting period of two weeks in New Jersey commences to run. If he needs medical attention or hospital attention, the liability to furnish it attaches at once to the employer. But outside of that, no liability has attached to the employer.

The workman is given two weeks' good care and attention. At the end of the two weeks, he is not completely recovered, but he is practically so. It is then that the employer's liability for compensation arises and that liability is based on the exact length of time after the waiting period that the workman is unable to return to work. If he returns to work three days after the waiting period has elapsed, then the employer is liable for only three days' compensation and not for three weeks and three days' compensation, as many employers would suppose.

A glance at Table I will show that the length in which the waiting period runs varies greatly in the different states. The chances are that it will be changed some more by the legislatures of the respective states, for there has been a tendency on the part of many to criticize the waiting period as being unnecessary, or at least too long.

Objections to the Waiting Period

There can be no doubt but that it does work a hardship on many workmen to have to wait three weeks before they receive any compensation, in many of the states, and then have the compensation amount, on an average, to only one-half of their average wages for the same period.

The average workman, even in the era of high wages, lives by a "hand to mouth" route and an accident generally catches him at a time when his resources are of the very lowest character. I have witnessed this again and again.

They have one big, outstanding objection to the waiting period and they have succeeded in making their objections heard in many jurisdictions. To the honest workman, there probably is no necessity of a waiting period, while for the small employer, especially the employer who is attempting to carry his own compensation risk, there certainly is a great need for it.

TABLE II. MEDICAL LIABILITY

	Amount	Time
Arizona	None	None
California	...	90 days
Colorado	$100	30 days
Connecticut	...	30 days
Illinois	200	8 weeks
Indiana	...	30 days
Iowa	200	4 weeks
Kansas	...	None
Louisiana	150	2 weeks
Maine	30	2 weeks
Maryland	150	.....
Massachusetts	No limit	.....
Michigan	...	3 weeks
Minnesota	200	90 days
Montana	50	2 weeks
Nebraska	200	21 days
Nevada	...	4 months
New Hampshire	...	None
New Jersey	50	2 weeks
New York	...	60 days
Ohio	200	.....
Oklahoma	...	15 days
Ontario	...	None
Oregon	250	.....
Pennsylvania	75	.....
Rhode Island	...	2 weeks
Texas	...	2 weeks
Vermont	75	1 week
Washington	...	2 weeks
West Virginia	150	None
Wisconsin	...	90 days
Wyoming	...	None

But of all the states in the union having compensation acts, only two, Oregon and Washington, have seen fit to dispense entirely with the waiting period. While it varies in the others as to time, the fundamental features of the example applied to New Jersey, above, applies in all the other states.

Iowa, however, occupies a unique position among the states in regard to the manner in which she has handled her waiting period. The period is left at two weeks, in order to secure all of the advantages of the long waiting period to employers; but if the workman's incapacity lasts more than seven weeks, he receives

extra compensation to cover the loss sustained by the two weeks waiting period in the beginning.

This is accomplished by "absorbing" the waiting period in the fifth, sixth and seventh weeks of incapacity, the workman receiving one-third of the two week's compensation during each of those weeks.

If a workman is drawing $9 per week compensation, he would receive that $9 compensation and in addition $6 in the fifth, sixth and seventh weeks of incapacity, so that at the end of that time, he would be entirely reimbursed for the loss occasioned by the waiting period.

The workman who is not incapacitated for seven weeks or even five weeks oftentimes raises a loud objection to this arrangement; but it is pointed out by the advocates of this method that he is no worse off than if he was under the ordinary plan. While not being incapacitated that long, he is able to return to work, drawing full wages, and does not need the extra benefit so much as the man who cannot return to work at once, but who must linger longer upon his compensation payment. The plan seems to be feasible for other states and it will doubtless do much, if adopted, to settle the disputes so often raised over the waiting period.

Only One Waiting Period in Each Case

Another point concerning the waiting period must be noted before we pass on to a consideration of other problems. It is a well settled rule of compensation practice that no more than one waiting period can be deducted from the workman's compensation for any one injury.

TABLE III. PERCENTAGE OF PAYMENT

Massachusetts	66⅔
New York	66⅔
Ohio	66⅔
California	65
Wisconsin	65
Kentucky	65
Texas	60
Iowa	60
Indiana	55
Ontario	55
Arizona	50
Colorado	50
Connecticut	50
Illinois	50
Louisiana	50
Maine	50
Maryland	50
Michigan	50
Minnesota	50
Montana	50
Nebraska	50
Nevada	50
New Hampshire	50
New Jersey	50
Oklahoma	50
Pennsylvania	50
Rhode Island	50
Vermont	50
West Virginia	50
Oregon	$30 to $60 per month
Washington	$15 to $60 per month
Wyoming	$15 to $35 per month
Kansas	$25 to $50 per month

Employers are fully aware of the fact that an injured workman will often attempt to return to work several days before he is physically able to do so. Oftentimes he suffers a relapse after working a day or two before being able to resume his employment permanently. And I have known workmen to try this many times before being able to take up the old work. This does not mean that every time a workman suffers a relapse that the employer can commence to deduct a new waiting period and thus either cheat the workman out of any compensation at all, or else practically force him to become a malingerer in self-defense.

The proper way to arrive at the amount due the workman is to add up the total number of days lost from work due to the injury in such a case and then deduct the number of days allowed by the waiting period and pay compensation for the balance remaining. This is fair to the employee and fair to the employer and when explained to the employee will make him a much better workman than to attempt to indulge in petty technicalities to escape the payment of a few dollar's compensation.

While Table III on the percentages of wages upon which compensation is to be paid, is valuable for employers, Table IV, which contains the minimum and maximum amounts which the employer is liable to pay, is probably more valuable.

The amount of the medical aid for which the employer is liable varies probably more than any other feature of the compensation acts, as a glance at Table II will show.

TABLE IV. MINIMUM AND MAXIMUM PAYMENTS

	Minimum	Maximum
Arizona	$4.16	$20.83
California	5.00	8.00
Colorado	5.00	10.00
Connecticut	6.00	12.00
Illinois	5.50	13.20
Indiana	6.00	15.00
Iowa	6.00	15.00
Kansas	3.00	10.00
Louisiana	4.00	10.00
Maine	5.00	12.00
Maryland	4.00	10.00
Massachusetts	4.00	10.00
Michigan	6.50	11.00
Minnesota	6.00	10.00
Montana	5.00	10.00
Nebraska	20.00	60.00
Nevada (month)	5.00	15.00
New Jersey	5.00	15.00
New York	5.00	12.00
Ohio	6.00	10.00
Oklahoma	.....	21.15
Ontario	.....	50.00
Oregon (month)	5.00	10.00
Pennsylvania	4.00	10.00
Rhode Island	5.00	15.00
Texas	3.00	12.00
Vermont	.....	35.00
Washington (month)	5.00	10.00
West Virginia	4.69	9.37
Wisconsin		

The legislatures of the states have recently passed amendments covering this feature, the majority of them increasing either the total money amount for which the employer is liable, or else extending the period of time over which the liability for the amount previously designated in the statute is to apply.

The Iowa legislature has increased the amount up to $200, in the discretion of the industrial commissioner, just doubling the amount previously granted. This is to extend over the first four weeks of incapacity and without that period the workman must furnish his own medical attention.

Employer's Maximum Liability Fixed

It is understood, of course, that the latter table governs, so far as minimum and maximum payments are concerned, the percentage table governing whenever practical. This is deemed necessary by the statutes because it was thought worth while to have the employer's maximum liability definitely fixed in order that he could have a definite basis of liability upon which to base his application for insurance elsewhere if he did not care to carry the risk himself, or was not permitted to do so by his state laws.

The map is principally worth while to employers doing a national business in that it shows at a glance just

what states have state fund insurance and what states permit employers to carry their own insurance, under reasonable regulations, or else insure it in private companies.

Obviously, where the state fund is in use, it is up to the employer to insure his compensation risk with the state fund and, indeed, this is made compulsory in most of the states having that basis of insurance.

It is not our purpose to enter into the merits of this subject, but state fund insurance has always met with instant approval on the part of the working classes because it insures them absolute protection in case of injury, in that the faith and credit of the state is back of their claim, while oftentimes private companies have fallen into the hands of receivers at the wrong time and compelled workmen to go without their full payment. In the latter instance, of course, the employer is still liable, being the person primarily liable, and the workman can ultimately recover compensation if his employer is financially able.

Increased Production by the Use of Proper Gages

By GEORGE T. TRUNDLE, Jr.

The intention of this article is to show that gages are extremely necessary wherever the quantity of production warrants making them. One of the factors in determining what this quantity should be, in order to render the use of gages economical, is the amount of scrap made in the manufacturing department by mistakes in reading scales, micrometers and other measuring instruments.

FROM the writer's experience, he thoroughly believes that gages will increase production rather than decrease it. The first problem in the manufacture of any device is to prepare a complete set of drawings and specifications in which the tolerances are designated. In establishing tolerances, there are so many things that must be watched, both from the manufacturing and the engineering standpoint, that the men undertaking this task should have: First, a thorough knowledge of the device to be manufactured; second, a thorough knowledge of the manufacturing methods used in that particular plant.

The writer has studied, with much interest, the article by Fred. H. Colvin, under the heading, "Standardization and Interchangeability: Factors Which Help or Hinder According to the Work in Hand," published in the *American Machinist*, page 1143, Vol. 50. The article is educational and should be read by every engineer and production manager.

Accuracy in Dimensions

On every device or machine, whether the parts go from the foundry direct to the assembling room or undergo various machining operations, there are some dimensions that require a certain degree of accuracy and this accuracy should be controlled by gages. It is not necessary that all gages should be made by high-grade toolmakers and held to one ten-thousandth of an inch. Neither do they need to be polished as though they were to be used for watch charms or ornaments. What we must have, however, are practical gages.

There have been instances where gages made with a hacksaw and file from sheet metal have not only saved many thousands of dollars, but their use has increased production. So, in speaking of gages, I mean practical gages.

Inspection and gaging of castings should start in the foundry. If a pattern becomes badly distorted, it is a waste of labor and money to continue making castings from it. The same conditions are true if there should be a change in the methods of molding, even though the patterns are perfect, that will cause the castings to warp so that they cannot be used. Many such castings have been returned to the foundry for this reason, though sometimes this condition was not discovered until numerous machine operations had been performed on them entailing great loss to the manufacturer. Very simple gages in most cases in the hands of a competent inspector in the foundry would eliminate this loss.

Cutting off rods to length, with a tolerance of plus or minus ten one-thousandths of an inch, is a very simple operation, no great accuracy being required. Give the job to an operator on a hand screw machine, without gages, and he will either spend time watching the length or the variation will be beyond the liberal tolerance allowed. I have known many instances where such lengths have varied one-eighth of an inch in either direction. The use of a simple snap gage, either a standard gage adjusted in the gage department or one made of sheet steel, would increase production and relieve the foreman of the worry as to whether the parts will be made correctly.

The point that I wish to bring out is the fact that a gage with fixed dimensions will save both the operator's and the foreman's time. There are times when there are numerous dimensions on a part to be machined; the operator must keep a blueprint directly in front of him or attempt to carry the dimensions in his head, unless he is provided with gages. Reading blueprints takes time, measuring by a scale and micrometer takes time, and there is always the possibility of mistakes. The attempt of the operator to carry the dimensions in his head is only inviting trouble.

Interchangeable Manufacturing

We want to send parts to the assembling room in lots where they must interchange with other parts and to send out repair parts that must fit. In order that these parts shall be right, the men establishing the tolerances must be familiar with both the device and the manufacturing facilities at hand and the one thing that they must be extremely familiar with is the parts that are liable to require replacement from wear.

In establishing tolerances, much thought should be given to the neutral point or clearance. For a hole

one inch in diameter with a plus tolerance of 0.002 in., the general practice is to make the shaft 0.999 in. with a minus tolerance of 0.002 in. Now, if the shaft comes to the minimum size and the hole to the maximum, there will be 0.005 in. clearance. In providing gages for this, we might make one plug gage for the hole 1.002 in. which must not go, and another one 1.00 in. which must go. One ring gage for the shaft we might make 0.999 in. which must go, and another one 0.997 in. which must not go.

If the neutral point is watched carefully, interchangeable manufacture can be accomplished with very little selective assembling. On most machines and appliances, the number of very accurate dimensions is small compared to those that do not require such accuracy; we must therefore lay stress on these points in our manufacturing department, make good gages, provide efficient inspection and do a given amount of selective assembling. It is oftentimes a waste of energy and money to scrap parts that are slightly outside of the tolerances allowed.

There should always be two sets of tolerances, one for the factory and one for the final-inspection department.

The tendency in the manufacturing department, where everyone is under tension to get out production, is to let a machine run just so long as the gage will pass the job. It is not long until the tool will wear or some slight change in the machine adjustment will cause the piece to be slightly off gage, either large or small. If large, it can in most cases be salvaged; if small, it must either be scrapped or we must do selective assembling. Had the inspector insisted on the machine being set more nearly half way between the two tolerances, the machine would operate longer and this defective work would have been reduced to a minimum.

Gages for Threads

The one point in manufacture that we have learned the most about during the war is threads, and it is my opinion that this is one of the most important points in production. However, I have never been convinced that a no-go thread gage is necessary. I maintain that, for a female thread, we should use a go thread gage and a no-go plain plug, and, for a male thread, a go thread gage and a no-go plain ring. This brings up a problem that is not yet thoroughly developed; what should be the drill size for a tapped hole? In other words, should we have 75 per cent. thread or 80 per cent.? Male threads are not so troublesome because the die must be given sufficient clearance and thread-milling has been so developed that extreme accuracy can be obtained by its use.

Between the male and female threads, there should be no neutral point unless the parts must be assembled by hand without the use of a screwdriver or wrench.

In summing up: Gages reduce manufacturing cost, eliminate spoiling material, increase production and give us more nearly interchangeable manufacture than is possible for us to accomplish in any other way.

I do not advocate as extensive a gage department as we have been compelled to maintain during the war, but in every manufacturing plant there should be an inspection department properly supplied with such gages of the requisite degree of accuracy as may be necessary, and with men to assist the foreman in controlling the quality of production.

A Remarkable Cylinder Welding Job

By L. M. Malcher

Superintendent, Welding Shop of Oxweld Acetylene Co., Chicago, Ill.

One of the 5000-hp. Allis-Chalmers twin tandem compound reversing steel rolling mill engines at the Farrell works of the Carnegie Steel Co., Farrell, Penn., that had been doing its full share in helping to win the war broke down two weeks after the signing of the armistice. In the accident, besides other parts, the left-hand low-pressure steam cylinder, Fig. 1, 70 in. inside diameter, was badly fractured, as a result of the breaking of a connecting-rod at the moment of reversal.

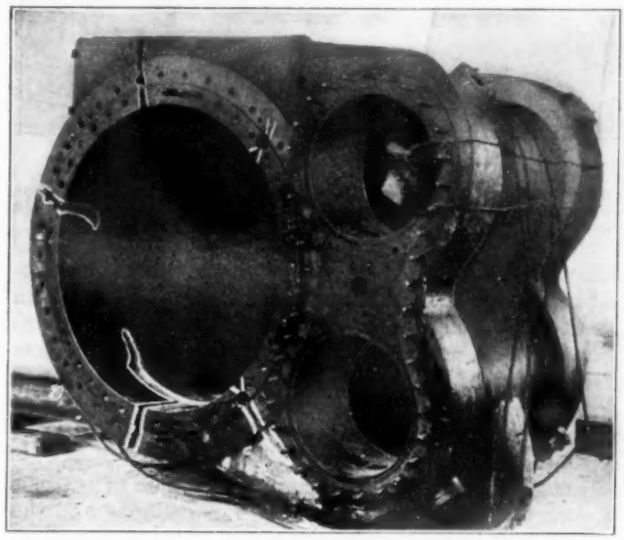


FIG. 1. WRECKED LOW-PRESSURE CYLINDER
The seven cracks ranged from 1 to 8 ft. in length and 2¼ to 3⅜ in. in depth and are shown V-grooved by chipping preparatory to welding.

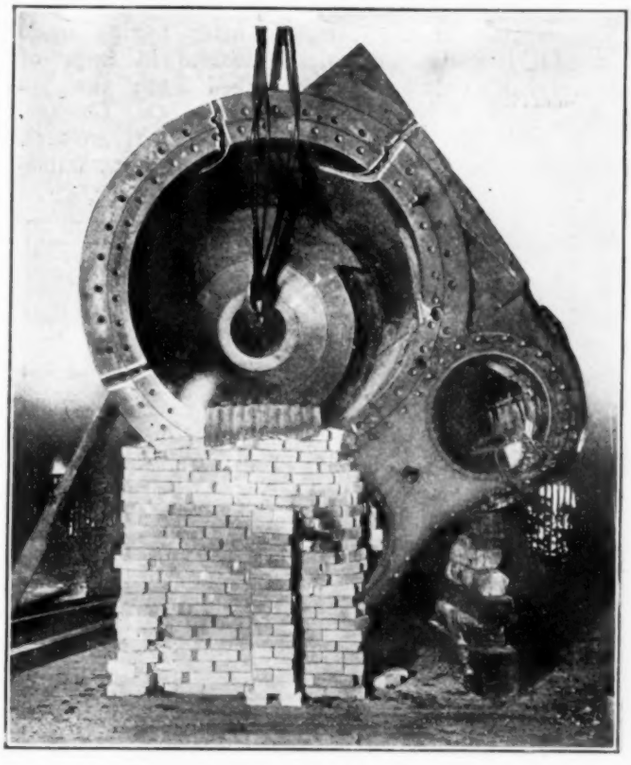


FIG. 2. PREHEATING CRACK IN LOW-PRESSURE CYLINDER BY MEANS OF CHARCOAL FIRE

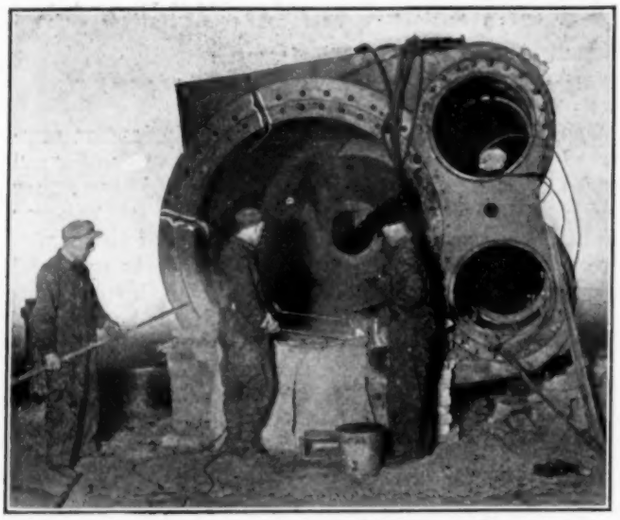


FIG. 3. WELDING THE LOW-PRESSURE CYLINDER

Asbestos paper was used to protect workers and retain heat from preheating fire. Note the extra long torches and rods required for the long cracks.

It would have taken at least three to three and one-half months to obtain a new cylinder, in case the broken one could not be repaired in a shorter time; besides throwing 360 men out of employment. The broken cylinder was of such size and the damage done was of such character that a decision whether the cylinder was to be renewed or repaired involved a risk on the part of the management.

Although it was decided that consideration of expense between the cost of purchasing a new cylinder and the repairing of the old one were of secondary importance, the cost of repairing was estimated to be about one-third that of a new cylinder.

Decide to Make Repair

The officials of the company after having made a careful investigation quickly decided in favor of oxy-acetylene welding. They called upon the job welding shop of the Oxweld Acetylene Co., Chicago, Ill., to meet the emergency. Three expert welders, accompanied by all necessary equipment, went immediately to Farrell and completed the job under the direction of the writer.

The fractures of the cylinders were what are commonly known as "end breaks"; that is, the cracks are on the extreme outside end of the casting. As a rule it is only necessary to preheat the casting locally and while the heat will radiate into the casting to some extent, the intensity is not enough to harm any portion by warping or shrinkage. The total time consumed in repairing the low-pressure cylinder, including chipping, preheating and welding, was 72 hours.

While dismantling the engine a fracture was discovered in the right-hand, 42-in. diameter, high-pressure cylinder. This fracture also was repaired in about 18 hours. It took just seven days from the time the order was placed to complete the entire job.

The data covering this work is given in detail in the accompanying table.

	Low-Pressure Steam Cylinder	High-Pressure Steam Cylinde
Cylinder bore	5 ft. 10 in.	3 ft. 6 in.
Stroke	4 ft. 6 in.	4 ft. 6 in.
Weight of cylinder	13 tons	5 tons
Thickness of iron casting	2½ to 3½ in.	3½ to 6 in.
Total length of weld	22 ft. 2 in.	4 ft. 6 in.
Preparing and preheating casting	27 hr.	9½ hr.
Welding casting	45 hr.	8½ hr.
Oxygen consumed	2,850 cu.ft.	650 cu.ft.
Acetylene consumed	2845 cu.ft.	650 cu.ft.
Cast iron welding rods	390 lb.	110 lb.
Flux	25 lb.	10 lb.
Number of welders	3	3
Period of welding shifts	10 and 30 min.	10 and 30 min

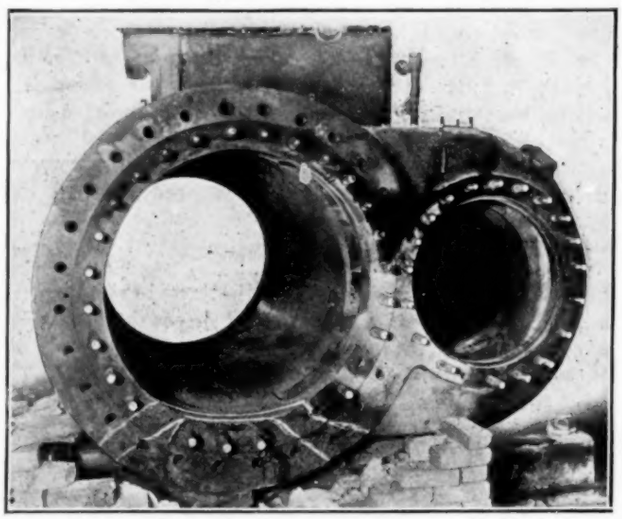


FIG. 5. FLANGE WELDED ON THE 5-TON HIGH-PRESSURE CYLINDER

Weld 4½ ft. long, 3½ to 6 in. deep

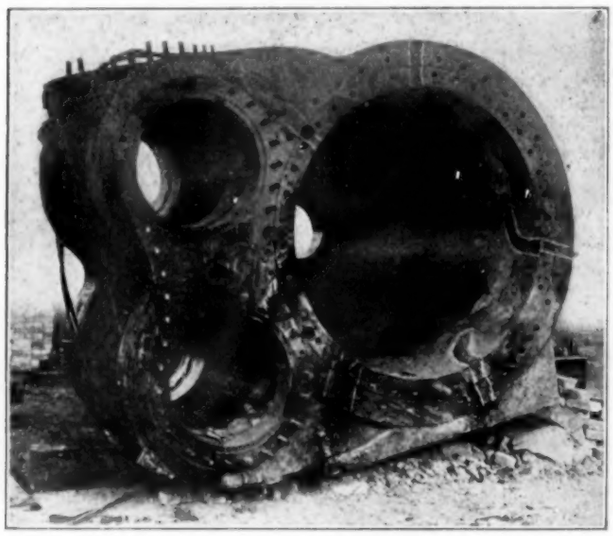


FIG. 4. WELDING OF LOW-PRESSURE CYLINDER COMPLETED

While welding inside of the cylinder castings the men relieved one another every 10 min. because of the extreme heat deflected back on them during the welding operation. On the outside welding, however, the heat was not so intense and the men relieved one another every 30 minutes.

After the engine cylinders were machined, it was almost impossible to determine where the cracks had occurred.

The total cost of the complete repair represented but a small fraction of the replacement cost but even this saving is insignificant when compared with the disorganization which would have resulted from the laying off of a large body of trained workmen and with the enormous loss that would have been entailed in a stoppage of production.

Making Special Snap Gages

By JOHN TECKEER

This article shows fixtures and describes methods of using them for grinding large and small snap gages so that they come out right the first time and do not have to be remade on account of warping. A method of regulating the pull of a magnetic chuck is also given.

AS STANDARD snap gages sometimes fail to meet all the requirements of certain jobs it is often necessary for the toolroom to make up special quantities of them for such cases.

Two common types are shown at *A* and *B* in Fig. 1. The first operation in their manufacture consists of shaping to thickness, leaving from 0.008 to 0.010 in. to take care of grinding. They are usually made of machine steel, $\frac{1}{8}$ in. oversize, and time can be saved by putting the whole batch through a series of cuts. Set the first chip to remove 3/64 in. and run all the gages through without changing the setting of the tool. Then take a $\frac{3}{64}$-in. cut off the other side in the same way and finally a finish chip off each side.

Lay out the holes on one gage, drill them and use this one as a jig for drilling the others one at a time. As a rule this gives better results than ganging the gages together and drilling them all at once.

Next pin together through the drilled holes as many of the gages as can be chucked conveniently, usually enough to make up a total thickness of 2 in. Square up the ganged gages, mill the slots, round the corners on one end and bevel them on the other. Then separate them and file, mark and harden each.

Straighten the Gages if Necessary

When the gages have been hardened they should be straightened if necessary and the sides surface-ground. They should then be ganged and ground with a cup wheel as shown at *C*, Fig. 1. The use of the cup wheel gives better results than can be obtained with the side of a wheel as shown at *D*, Fig. 1, on account of the difficulty of obtaining as straight or as parallel sides by the latter method and also because of the possibility of poor spindle alignment. The number of gages ganged is limited by the width of the gage opening and the inside diameter of the cup; in other respects this method has the advantage.

It is sufficient to leave a total of 0.0002 or 0.0003 in. for lapping, which should be done before the gang of gages is disassembled, as it is easier and quicker to lap eight or ten thin gages together than to do each one separately. In lapping, use a carborundum or india stone that does not scratch, and stone in one direction until the grinder marks disappear. Occasional checking with a straightedge will be necessary until the operator becomes experienced.

Try your size block thoroughly and honestly and watch the corners. If too tight, stone in the opposite direction and thus prevent rubbing low spots in your gage. The surface can easily be followed by crossing the previous lines made by the stone. Watch the corners to prevent bell mouth. A cast-iron hand lap and fine carborundum or alundum will take out the last 0.00005 in., leaving the surfaces well finished, straight and parallel. For one who has had little experience it is advisable to grind the lap the size of the opening and carefully work it through until the opening is lapped to size. It then requires an effort to make the jaws anything but parallel. For the experienced hand these laps can be any convenient size, and he can lap each size separately, confident of the resulting accuracy of the gage. The lap should be ground opposite the way it will be used, as it will cut easier and not line the work. When the gages are lapped, separate them and break the sharp corners.

In Fig. 2 *E*, *F*, and *G* are gages well suited to meet the requirements of gaging a thin, wide unit and are simple to make. Satisfactory results are obtained by using cold-rolled steel for the various parts which are ganged, milled to length and the bevels and rounds milled on opposite ends. An inexpensive drill jig is made to insure duplication from which the parts come rapidly and eliminate hours of laying out. As many parts as the magnetic chuck will hold are then ground, taking about 0.005 in. off each side, which insures the carbon penetrating and leaves a clean, black surface after hardening. The parts are ground and lapped only on the gaging surfaces.

Trouble in Grinding Blocks Less Than $\frac{3}{16}$-In.

In grinding blocks less than $\frac{3}{16}$ in. thick you may have trouble, and as the thickness decreases the certainty of trouble increases. Thin pieces tend to curl away from the chuck on the ends, thus grinding the ends low and making it difficult to obtain a straight surface on either side. This of course applies to any hardened thin piece and the same remedies will answer for all. The trouble lies partly in the use of the magnetic chuck, but mostly in the heating due to the emery-wheel action.

To get perfect results we must first find a method of reducing the attraction of the magnetic chuck so that it will not pull the piece hard on its surface, with the resulting displacement after it is released, and second, adopt a wheel or method of using a wheel that will not heat the work.

Various methods of reducing the attraction of the chuck are used with more or less success, but one method to avoid is that of sealing the work with beeswax or shellac. I have even seen a piece tacked with solder. While this method does overcome the chuck trouble it puts you in bad with the emery wheel, and without your knowledge until the work is taken out, when the released strains pull the piece anything but flat.

A piece of gage stock or anything suitable, 4 in. or 5 in. square and slightly less in thickness than the piece to be ground, should be placed on the chuck, the switch thrown in, then pulled out and contact made at the opposite poles to demagnetize the chuck. It will be found that the large piece clings tightly, and a very slight attraction is still felt from the chuck. This is the ideal

condition giving a positive stop against which to place the center block and just attraction enough to hold it. Other methods of applying the same principle can be devised, such as the use of parallels of different heights, which will give the same result, but mention of this one method is made because of its simplicity and satisfactory results.

To reduce heating the best results are obtained by using a coarse, soft wheel as a rougher and finishing with a finer-grained though equally soft wheel. These wheels should have nicks ground in their periphery about 2 in. apart, as they help to reduce the heating tendency. The wheel face should be cut away to about ⅛ in. wide and used with care. When grinding the pieces keep trying them for straightness and turning the sides alternately to the chuck. It is quite possible to grind very thin pieces in this manner, with sides straight and parallel. However, the finishing must be done with cuts which vary with the thickness of the piece and may be less than 0.0001 in. deep. When the gages are assembled and have passed inspection seal the holes with plaster of paris, which is easily mixed and applied and seals against tampering.

In Fig. 3, *H* and *J* are types of the large snap gage and may have openings of 12 in. or more. These can be satisfactorily ganged in all operations previous to the grinding, which should be allowed only on the gaging surfaces. One particular annoyance with these large gages is that the surfaces do not come from the grinding machine parallel to each other due to springing them slightly in the clamping. The necessary precaution in clamping can be reduced to a minimum if a fixture is made similar to the sketch at *K*, Fig. 3. With this the grinding is done rapidly and accurately. A cup wheel is used as shown, thus permitting the surfaces to be ground flat and parallel right up to the corner. In this case you again have the advantage of the graduated handwheel for measuring and grinding to the desired size. Leave 0.00015 in. on each surface and lap as previously outlined.

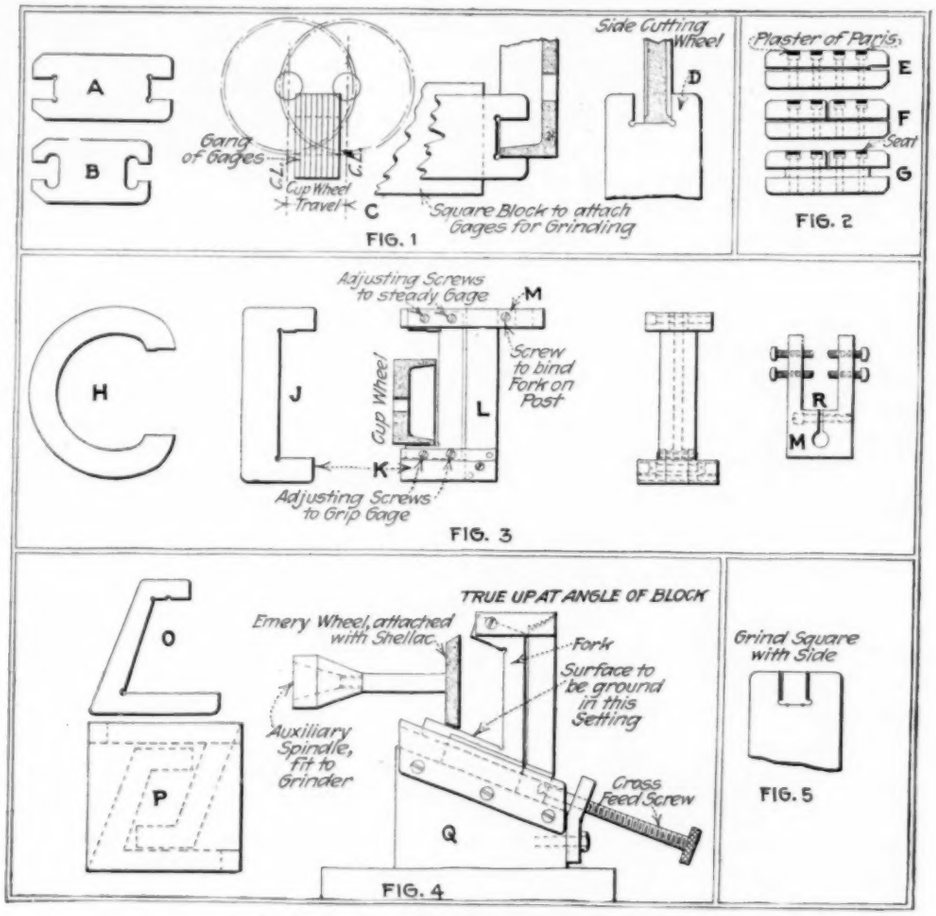
The fixture is made of three parts—a stout center stud L of a length to accommodate the range of your grinding machine, a base *K* screwed and doweled permanently in place, and a sliding fork M with a binding screw to clamp it to the center stud and adjusting screws to support the upper end of the gage. When the gage is pinched on the bottom and squared up the adjusting screws are brought in contact, but not enough to spring the gage either way. The gage is then steady to grind and parallel surfaces may easily be obtained.

Another type, and one that presents a more difficult grinding problem, is shown at *O*, Fig. 4. This type is best handled by cutting the stock in lengths and widths to permit of two gages being cut from each piece, as seen at P, Fig. 4. The job is then carried through, as previously outlined, up to the grinding.

An auxiliary spindle and inclined block are used for making this type of gage. The same type of holder (in some cases the same holder) used on the other long gages can be used to hold it. The slight changes necessary can be seen in the sketch at Fig. 4. The inclined block is the same width as the holder base and has a side plate attached on each side with a projection lapping over the top of the holder base. This makes a simple and satisfactory slide in which the holder travels while grinding the long surface of the gage.

Grind the long surface first, then remove the gage and holder intact from the angle block, which can be done by removing the pin attaching the feed screw to the holder base and sliding the holder out of the upper end. Place the holder direct on the magnetic chuck and grind the top step to measurement similar to the manner shown in Fig. 3.

To use the fixture advantageously where a number of gages are to be ground two grinding machines are nec-



FIGS. 1 TO 5. MAKING SNAP GAGES

Fig. 1—Small snap gages. Fig. 2—Gages for thin, wide pieces. Fig. 3—Fixture for large gages. Fig. 4—Special Gages and Fixture. Fig. 5—Built-up snap gage.

essary, due to the inconvenience of changing the wheels for each operation, or better still have two fixtures and two men, each carrying through one side of the job.

A method of building up snap gages for gaging thin, narrow pieces is shown in Fig. 5. In this case the large opening in the gage body is ground on a parallel block, as shown in Fig. 1, to any convenient size. The insert is then fitted, removed and the gaging sides ground parallel to the sides of the body piece.

This is done by first grinding the top of the assembled gage square to the sides, removing the insert and squaring up its sides to the ground surface.

After grinding replace this insert and measure the opening. Then, knowing the amount to be taken off, remove and grind to measurement. Replace, check and sweat in place. The small holes help in sweating. A piece of machine steel ground a snug fit in the slots will make an excellent lap and will clean out 0.0002 or 0.0003 in. easily and give well-finished, parallel jaws.

Foundations

BY W. OSBORNE

A number of the men were sitting around during the noon hour and the talk naturally drifted to consideration of a strike then in progress.

These men were part of a gang that was building an improved road, and as such work had not as yet been "organized" their opinions may be considered as the expressions of their thoughts.

After various views had been voiced, some one asked "Old Charley" to tell what he thought.

Charley was the "handy man" of the combination. He kept the machinery in repair. He was looked up to

as being a man who could fix anything that could be fixed, and as one who could get along with any man that any other man could get along with.

Charley did not seem disposed to take part in the discussion.

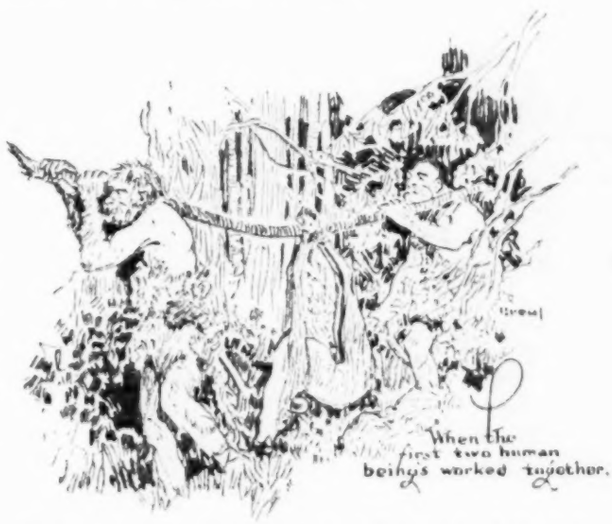
"Don't you have any ideas, Charley?" banteringly exclaimed the youngster who ran the concrete mixer.

"What is the use of turning over an idea to a fellow like you who can't reason with it, when he has it? You take an idea and put it in your memory, and when you want it you can't find it. You can't reason out how to fix a wheelbarrow so it will work right."

The laugh that followed this reply from Charley indicated that the youngster was not very mechanically inclined, but it took more than a laugh to silence him, for he came back with, "This isn't a machine that we are talking about. It's a strike. Forget your 'essential fundamentals' and your 'basic principles,' and that other stuff that you like to get off when I ask you a simple question about machinery and tell us how you think it is going to turn out."

"Huh!" snorted Charley. "You want your mental food chewed for you about this just as you do about everything else. Well, young fellow, all you're going to get from me on this subject is more of them 'essential fundamentals,' and more than likely they will give your reasoning powers indigestion.

"All permanent human association is founded on 'service' or 'mutual helpfulness' and it started when the first two human beings worked together. It has continued down to the present time and is the foundation of the family, the tribe, the state and the nation. It is the foundation of religion. No matter how poor the thing that was built on the foundation, the foundation was that, and it was right.



"What is the foundation of strikes and of the labor movement that glories in them? It is 'coercion' or 'bulldozing.' Some day, an 'organizer' will come along and he will tell you that he is going to organize the road builders; and he will tell you to get busy and get in; and, if you don't move to suit him, he will tell you that you will not be allowed to work at this or any other work that is 'organized'; and he will tell you that when all the road workers are organized you can make the contractors come across with any wages and hours that you ask for."

"From what I can see he won't be very far off at that," replied the youngster.

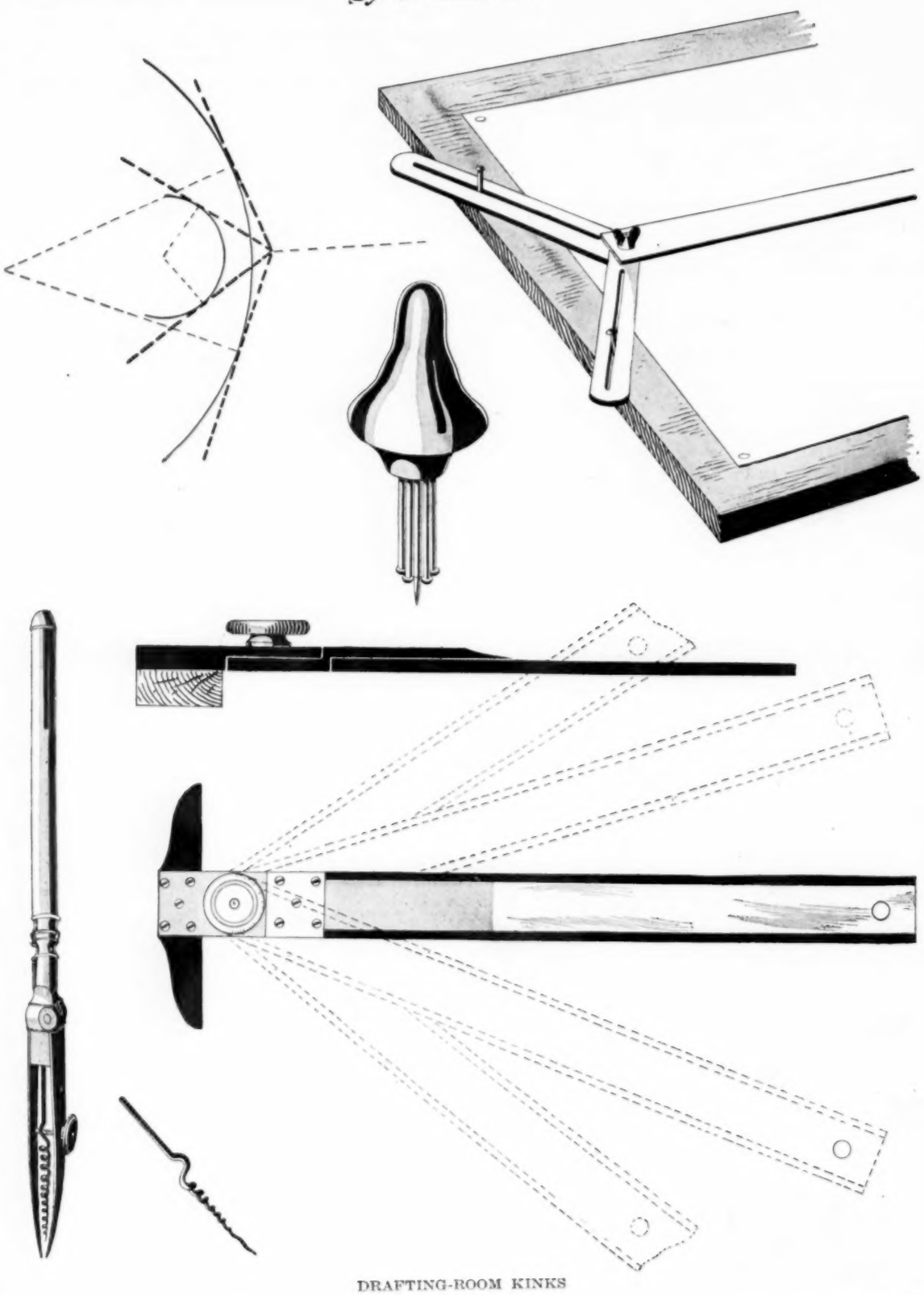
"You are right for a little ways," said Charley. "As long as the rest of the world is too busy to pay any attention to you, and the contractors can pass it along without any trouble, it will work; but your foundation is wrong for all of that, and if you build big enough on it it is going to let you down. If this sort of 'organization' is good for one class it is good for every class. If the 'strike' is a good weapon for one class it is a good one for every class. Just keep on thinking.

"Carry it to the point where every one has to look to an organization for their rights and you are reversing the process that has built up civilization. One would hardly expect that it would keep on going backward until it would land us back in the stone age, but if you and I cannot do any thinking for ourselves it may go a longer ways back than we will like."

Just then the whistle blew and the gang started in on the afternoon work.

FOR SMALL SHOPS *and* ALL SHOPS

By J. A. Lucas



DRAFTING-ROOM KINKS

Results of a Series of Tests of Water-Quenched Free-Cutting Steel

BY C. P. MILLER

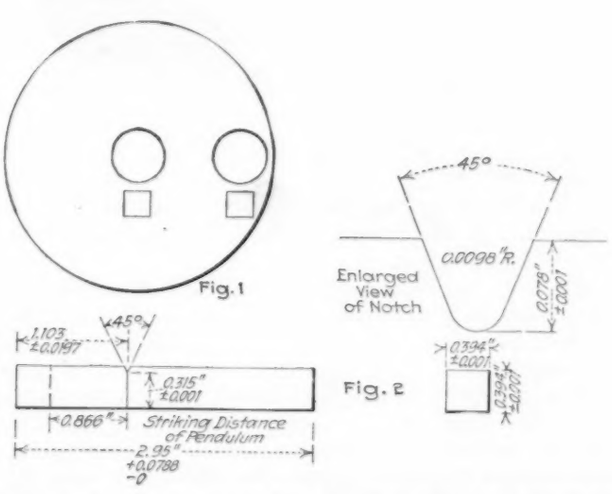
Steel used for screw-machine stock is usually used in an untreated condition, as received from the mill, and the purpose of this article is to present the results of tests upon it both untreated and water-quenched, and to show the great improvement in the physical properties of the latter treatment.

FREE-CUTTING openhearth steel is widely used for such parts as bolts, nuts, studs and other members where strength is not such an important consideration as ease of machining and the ability to produce smooth threads. It is often called screw-machine stock from its adaptability for this line of work. The usual composition, according to the standard of the American Society for Testing Materials, is as follows: Carbon, 0.15 to 0.25 per cent.; manganese, 0.60 to 0.90 per cent.; phosphorus, not over 0.06 per cent.; sulphur, 0.075 to 0.15 per cent.

A portion of the sulphur is added during the manufacture of the steel and to its presence is due the free-cutting qualities.

The tests were performed upon specimens 4¾ in. long, cut from 1-in. diameter and 4-in. diameter bars, all the specimens for each size being cut from the same bar. The composition of the bars was as follows: For the 1-in. diameter bar: carbon, 0.22 per cent.; manganese, 0.65 per cent.; phosphorus, under 0.04 per cent.; sulphur, 0.106 per cent. For the 4-in. diameter bar: carbon, 0.23 per cent.; manganese, 0.71 per cent.; phosphorus, under 0.04 per cent.; sulphur, 0.087 per cent.

Two sizes of bars were used in order to determine the increase in strength of a small bar over a large one, due to the greater reduction in rolling of the former; and, in addition, to ascertain the effect of a variation of mass upon the speed of quenching and depth of penetration of quench, and the corresponding physical properties.



FIGS. 1 AND 2. LOCATION OF TEST PIECES IN 4-IN. BAR AND IZOD IMPACT TEST PIECE

The following tests were made:

1. Two 1-in. diameter specimens were tested as received, one being used for tension and the other for impact test.

2. Two 1-in. diameter specimens were quenched in water from a temperature of 1550 deg. F., one being used for tension and the other for impact test.

3. Two 4-in. diameter specimens were tested as received, an impact and tension test piece being taken from both the center and from a point near the surface so as to obtain the effect of rolling upon the interior as compared with the surface.

4. Two 4-in. diameter specimens were quenched in water from 1550 deg. F., an impact and a tension test piece being taken from both the center and from a point near the surface so as to show the effect of penetration.

The location of the test pieces for the 4-in. diameter specimens is shown in Fig. 1.

The tension test pieces were turned to a diameter of 0.505 in. along the gage length and the ends were threaded to fit the grips of the testing machine. The impact test pieces were made according to the standard Izod form shown in Fig. 2. These test pieces were broken as cantilever beams by the action of a knife-edge fastened to a pendulum bob.

TABLE SHOWING RESULTS OF THE TESTS

	1-In. Diameter	
	Untreated	Water-Quenched
Tensile strength	67,500 lb. per sq.in.	85,400 lb. per sq.in.
Yield point	42,900 lb. per sq.in.	54,800 lb. per sq.in.
Elongation in 2 in.	32.0 per cent.	25.0 per cent.
Reduction of area	54.6 per cent.	59.0 per cent.
Impact strength	53-61 ft.-lb.	73-81 ft.-lb.
Brinnell hardness	124	159
Shore hardness	24	29

4-In. Diameter. Untreated	Center
Tensile strength	56,110–56,000 lb. per sq.in.
Yield point	26,750–28,350 lb. per sq.in.
Elongation in 2 in.	36.0 per cent–36.5 per cent.
Reduction of area	59.8–57.2 per cent.
Impact strength	28-31–28-30 ft.-lb.
Brinell hardness	107–107
Shore hardness	25–25

4-In. Diameter. Untreated.	Surface
Tensile strength	57,900-57,500 lb. per sq.in.
Yield point	30,500-29,350 lb. per sq.in.
Elongation in 2 in.	36.0 per cent.-35.0 per cent.
Reduction of area	59.8 per cent.-59.8 per cent.
Impact strength	21-10–19-27 ft.-lb.
Brinell hardness	107-112
Shore hardness	25-25

4-In. Diameter. Water-Quenched	Center
Tensile strength	68,700-68,500 lb. per sq.in.
Yield point	48,200-47,900 lb. per sq.in.
Elongation in 2 in.	32.0 per cent.-33.0 per cent.
Reduction of area	64.7 per cent.-67.0 per cent.
Impact strength	76-83–74-79 ft.-lb.
Brinell hardness	149-149
Shore hardness	28-28

4-In. Diameter. Water-Quenched	Surface
Tensile strength	69,800-70,800 lb. per sq.in.
Yield point	52,800-51,60 lb. per sq.in.
Elongation in 2 in.	32.0 per cent.-29.0 per cent.
Reduction of area	69.2 per cent.-71.3 per cent.
Impact strength	80-80–84-85 ft.-lb.
Brinell hardness	149-156
Shore hardness	28-27

After each tension test piece was broken, a flat was milled on the threaded portion of one end and Brinell and Shore hardness tests were carefully made. Ex-

perience has shown that at this point of the test piece, the material is unaffected by the stretching along the gage length and a true hardness record can be obtained. The complete results of the tests are given in the accompanying table.

In addition to the tests, photo-micrographs, Fig. 3, were taken of the untreated and water-quenched 1-in. diameter bars, and the greatly improved structure of the quenched bar is obvious.

What the Results Show

A summary of the results shows that water quenching raises the tensile strength of the 1-in. diameter steel 27 per cent., the yield point 28 per cent., the reduction of area 8 per cent., while the elongation is decreased 22 per cent. The hardness has, of course, been increased, but not to a sufficient degree to affect the cost of machining.

The results are shown even more strikingly in the case of the 4-in. diameter bars. Here the water-quenched bars average 23 per cent. higher in tensile strength, 76 per cent. in yield point, 15 per cent. in reduction of area, and 230 per cent. in impact strength, while the elongation is decreased 8 per cent. As in

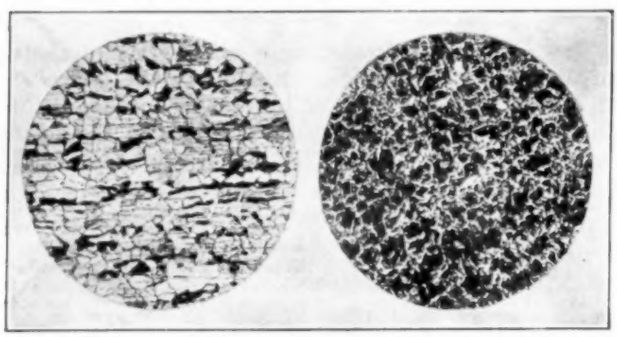


FIG. 3. PHOTO-MICROGRAPHS OF 1-IN. BARS (100 DIAMETERS)

the case of the 1-in. diameter bars, the increase in hardness is negligible. The tests also show that there is very little difference between the properties at the surface and those at center of the 4-in. diameter bars, either in the untreated or water-quenched condition; a slight increase in strength in the surface test pieces being the only characteristic noticeable.

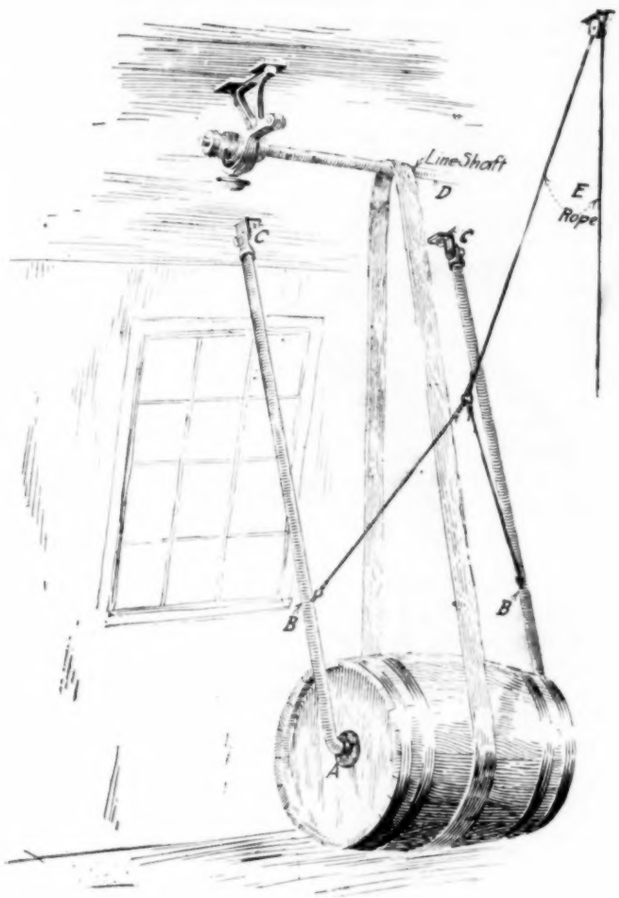
The effect of the difference in size betwen the 1-in. diameter and 4-in. diameter bars upon the strength is very evident, especially for the untreated steel. In this case, the tensile strength of the 1-in. diameter bar is 19 per cent. greater, the yield point 50 per cent. greater, and the impact strength 140 per cent. greater. With the water-quenched steel, the tensile strength of the 1-in. diameter bar is 23 per cent. greater, the yield point 9 per cent. greater, and the impact strength practically identical.

The conclusions drawn from these tests are: (1) The tensile and impact strength of free-cutting steel is greatly increased by water quenching (in this connection it should be stated that the decrease in ductility is of no significance for the toughness and resistance to shock are shown by the impact test); (2) that the increased hardness due to water quenching is not great enough to cause difficulty in machining; (3) that the larger bars are much lower in tensile strength than the smaller ones and that in designing, figures should be used which are based upon tests of bars of approximately the same size as those contemplated in the design; (4) that the impact strength of the larger bars in an untreated condition is very low, but can be greatly increased by quenching, and (5) that the tests show greatly improved general qualities for the quenched steel, a fact which can be readily deduced from a comparison of the structure shown in the photo-micrographs.

A Simple Tumbling Barrel

By Frank C. Hudson

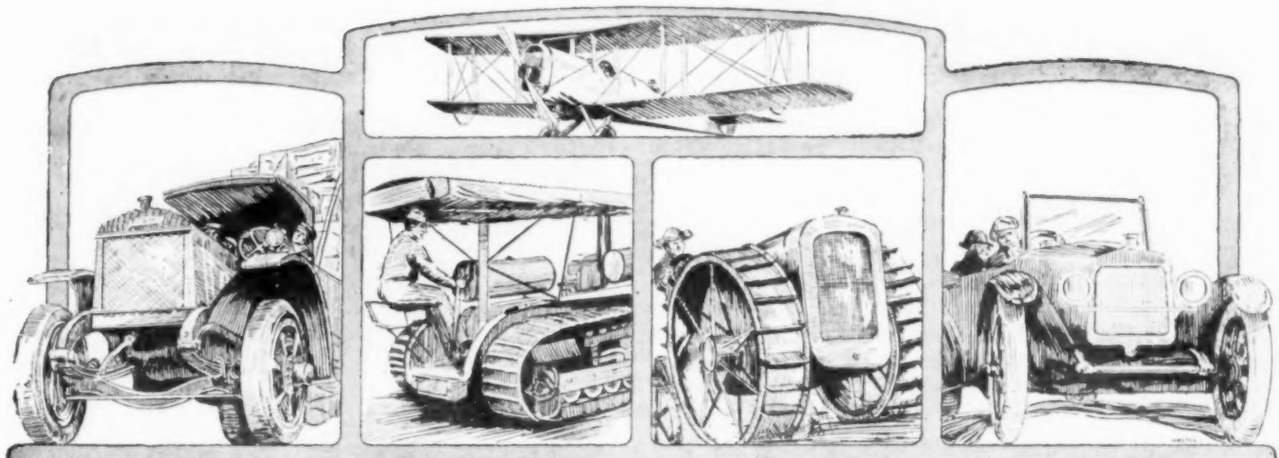
In some classes of work, tumbling is extensively used and there are probably many more shops where it could be used to advantage on small work. The illustration shows a simple tumbling barrel made from a substantial wooden keg *A*, suspended from the ceiling by



A SIMPLE TUMBLING BARREL

the framework of pipe *B*. It will be noticed that the upper end of the frame *B* hangs in a bracket at *C* behind the lineshaft *D*.

The tumbling barrel is driven by a belt which runs on the lineshaft and around the center of the keg. The angle of the framework *B* provides the necessary tension to insure positive driving, while the rope *E*, running over a pulley in the ceiling, allows this to be varied or to be raised out of contact when it is desired to load or unload the tumbling barrel. This makes a very simple tumbling barrel for the small shop and one which will be found extremely useful in many cases.



AUTOMOTIVE CONSTRUCTION

Connecting-Rod Forgings for the Liberty Motor

By H. A. CARHART, M. E.
Lincoln Motor Co., Detroit, Mich.

The forging problems of the Liberty motor connecting-rods were solved in various ways by different makers, the different methods being briefly described. The following article also points out the numerous difficulties of handling chrome-nickel steel and shows how the rods were heat-treated and tested.

THE connecting-rods for the Liberty motor were made from chromium-vanadium steel, containing carbon, 0.30 per cent. to 0.40 per cent.; manganese, 0.50 per cent. to 0.80 per cent.; phosphorus, not over 0.40 per cent.; sulphur, not over 0.04 per cent.; chromium, 0.80 per cent. to 1.10 per cent.; vanadium, not less than 0.15 per cent. This steel is ordinarily known in the trade as 0.35 carbon steel, S. A. E. specification 6135, which provides a first-rate quality steel for structural parts that are to be heat-treated. The fatigue resisting or endurance qualities of this material are excellent. It has a tensile strength of 150,000 lb. minimum per sq.in.; elastic limit, 115,000 lb. minimum per sq.in.; elongation, 45 per cent. minimum in 2 in.; and minimum reduction in area, 45 per cent.

FIG. 1. FORKED-ROD FORGINGS BY PACKARD

The plain-end rod is forged from a flat bar with rounded corner, which is approximately the size of the large end of the rough forging, or about 1½ x 3½ in. The blank is cut from the bar by power shears, to a length which will forge out into a finished rod, with a small tong hold or gate, and as little flash as is practicable. This blank is heated in an oil-fired forge furnace, and swaged down along the center to draw the shank out to the proper length to match the die impression. The piece is then broken down to the approximate shape of the rod. It is then placed in the finishing impression and struck again to straighten and size it, and is allowed to cool slowly so as to somewhat reduce the forging strains. The center hole in the large end of the rod is then punched out, and it is snag-ground and cleaned up.

The forked rod is forged from larger stock than the plain-end, in approximately the same way, up to the trimming operation. It is forged with the heavy end solid, and several different methods are employed to form the fork.

The method of the Western Drop Forge Co., Marion, Ind., is to part the fork end of the forging by two distinct operations. First, a ⅛-in. plate is forced half way through the forging from one side. The plate is knocked out, the flash removed, the rod reheated, and the plate is forced in from the opposite side to complete the slot. This is done in an Ajax 4-in. upsetting machine. The rod is again heated, and in the same machine as above, clamped in dies and a formed punch, forced in from the end. This spreads the fork and squares up the sides to shape. Just above this die in the upsetting machine is a finishing die with formed ram, which does the final straightening and forming.

A method used at the Buick works is to forge the forked end solid and of full width. Then the fork

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section is punched about three-quarters of the way through, leaving a tie strip between the outer points of the fork. The rod is reversed and the punched portion pushed back and out, leaving the fork formed complete, except the tie piece, which held the rod in shape during the heat-treatment. This is machined out later.

Still another method employed a hot saw to do the slitting. The operations of spreading and straightening were practically the same as described in the preceding method. This method was originally used by the Canton Drop Forge and Machine Co., but was discontinued in favor of the following: After the forging had been trimmed, it was heated for the operation of parting. A 4-in. Ajax upsetting machine was arranged with three sets of suitable dies one above the other. The ram carried a parting blade, about $\frac{5}{16}$ in. thick at the bottom. Opposite the middle die was a formed punch of about the general shape of the inside of the fork. The finished punch for the upper die was a block of correct shape, mounted on the end of a bar which served as a handle.

The heated rod was inserted in the bottom die and the first operation of the upsetting machine forced the slitting blade into the end of the rod to the proper depth. The rod was then moved to the next die above and the second operation on the upsetting machine brought the formed punch into the end of the rod, thus spreading and forming the forked end. The rod was then placed in the finishing die at the top. An assistant held the finishing punch in front of the ram as it came forward and the rod was finish-formed and straightened. All of this was done at one heating.

The Packard Motor Car Co. uses another method, in which the forked end of the rod is forged to the full thickness of the finished rod. Then the stock between the two forks is punched out from one side of the rod, leaving the forked end in nearly finished shape and without setting up stresses in the metal. The end is then shaped up in finishing dies. Fig. 1 shows the rod before and after punching out the forked end.

Another Method

The original material specifications, which included specifications for the heat-treating of the parts, were taken in hand by the inspection department of the Lincoln Motor Co. and the treatment started on the first batches of parts under the supervision of the metallurgical inspection department. The first forgings were

FIG. 2. RODS IN FURNACE

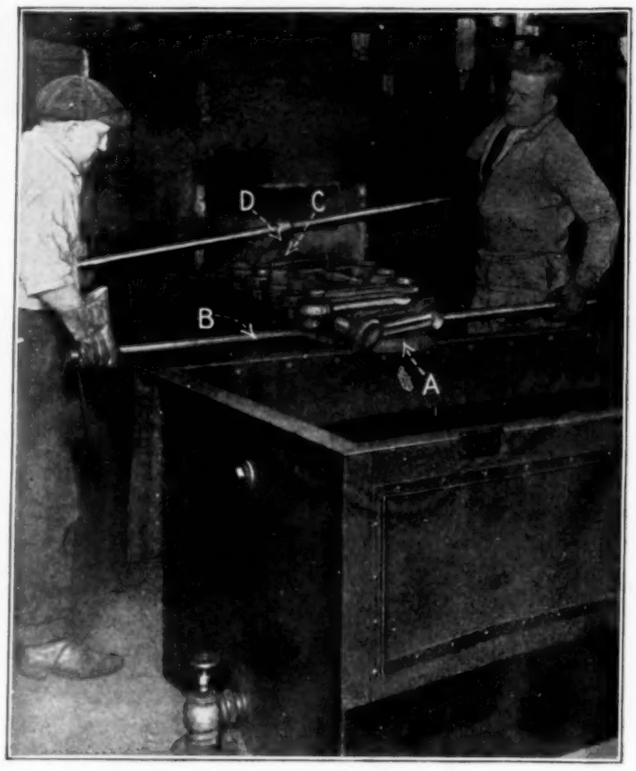

FIG. 3. QUENCHING RODS

hand machined and parts were treated at a number of commercial heat-treating establishments of Detroit.

The connecting-rods, both plain and forked, caused a great deal of trouble and loss right along. As matters were growing worse, the Lincoln Motor Co. undertook an investigation of the difficulty, with a view of eliminating the cause. The connecting-rod forgings were developing cracks before, during, and after heat-treatment. The steel-mill representatives and the drop-forge men making the rod forgings, were called in consultation. The Lincoln Co. insisted that although part of the trouble might be due to heat-treating, and part of it to poor stock, the principal difficulty lay with the fact that the chromium-nickel steel used required extremely careful handling, due to its inherent quality of resisting physical changes.

The Signal Corps was asked to change the specification from chromium nickel to chromium vanadium, which would benefit all concerned, owing to the fact that chromium vanadium, although capable of being treated to just as high physical property, is very much easier to handle.

The Signal Corps, after the matter was carefully gone over, concurred in this suggestion, and at the instance of the Lincoln executive, called a meeting of the representatives of the steel mills engaged in the manufacture of material for Liberty motors, and the drop-forge men making the principal forgings. After considerable debate, it was decided that owing to the difficulty of handling, in the manufacture of the steel, and in the production of the forgings, it would be best to substitute chromium vanadium for chromium nickel.

The original production system as outlined for the

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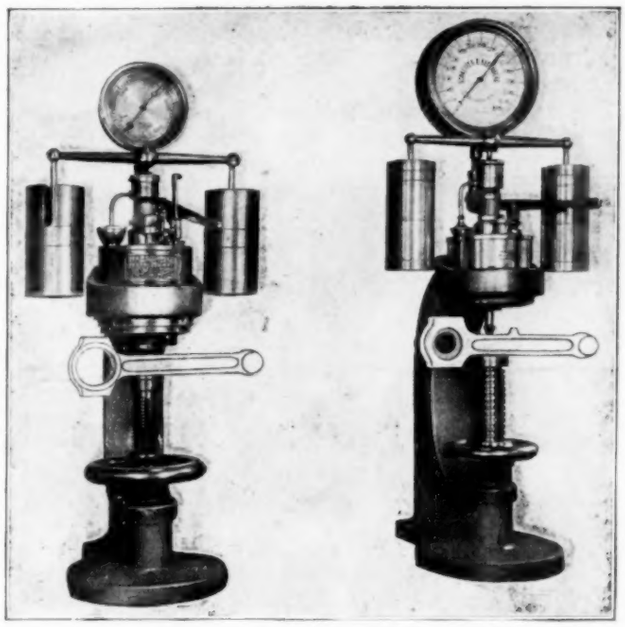

FIG. 1. BRINELL TESTING

manufacturers had called for a heat-treatment in the rough-forged state for the connecting-rods, and then semi-machining the rod forgings before giving them the final treatment. The Lincoln Motor Co. insisted from the first that the proper method would be a complete heat-treatment of the forging in the rough state, and machining the rod after the heat-treatment. After a number of trial lots, the Signal Corps acceded to the request and production was immediately increased and quality benefited, by the change. This method was later included in a revised specification issued to all producers.

The original system was one that required a great deal of labor per unit output. The Lincoln organization developed a method of handling connecting-rods whereby five workmen accomplished the same result that would have required about 30 or 32 by the original method. Even after revising the specification so as to allow complete heat-treatments in the rough-forged state, the ordinary methods employed in heat-treating would have required 12 to 15 men. With the fixtures now in use, five men handle 1300 connecting-rods, half of which are plain and half, forked, in a working period of little over seven hours.

The increase in production was gained by devising fixtures which enabled fewer men to handle a greater quantity of parts with less effort and in less time.

Change in Design Suggested

A change in design of the forked connecting-rod and its cap, and a little later of the plain connecting-rod and its cap, was suggested by the metallurgical force of the Lincoln plant early in production. This was that the cross-section of the metal at the lock notches in the rod by the bolt head, and also the cross-section of the metal in the cap by the nut seat, should be increased so as to obviate the danger of breakage through these notches. A practical demonstration of the principles involved in this change was arranged to convince all concerned that the change would be beneficial. This was done by shaping a number of rods as they should be, with increased cross-section, and as heavy a radius as possible for a fillet instead of a sharp-notched corner, as in the original design, and then alternately stressing the parts until they failed. The fact that the advocated design with heavy cross-section and rounded notches withstood over 20 times the stress that the original design withstood, clinched the argument.

Preliminary Inspection

The rods are received from the Western Drop Forge and Canton Drop Forge companies. Each rod is inspected by use of templet and calipers. Particular attention is paid to length of all bolt bosses and piston-pin bosses, and to the position of fork in relation to channel in forked rod. A visual inspection is also given to detect any cracks or cold shuts. The capacity is 400 rods in 9 hr., with one man for either single or double rods.

Both the single and forked rods are subjected to practically the same form of treatment and we shall treat the preliminary inspection and operations of both rods jointly until the major machine operations began.

In heat-treating, the forgings are laid on a rack or loop *A*, Fig. 2, made of 1¼-in. double extra-heavy pipe, bent up with parallel sides about 9 in. apart, one end being bent straight across and the other end being bent upward so as to afford an easy grasp for the hook. Fifteen rods are laid on each loop, there being four loops of rods charged into a furnace with a hearth area of 36 x 66 in. The rods are charged at a temperature of approximately 900 deg. F. They are heated for refining over a period of 3 hr. to 1625 deg. F., soaked 15 min. at this degree of heat and quenched in soluble quenching oil.

In pulling the heat to quench the rods, the furnace door is raised and the operator pulls one of the loops *A*, Fig. 3, forward to the shelf of the furnace, supporting the straight end of the loop by means of the porter bar *B*. They swing the loop of rods around from the furnace shelf and set the straight end of the loop on the edge of the quenching tank, then raise the curved end *C*, by means of their hook *D* so that all the rods on the loop slide into the oil bath.

Before the rods have cooled entirely, the baskets in the quenching tank are raised and the oil allowed to partly drain off the forgings, and they are stacked on curved-end loops or racks and charged into the furnace for the second or hardening heat. The temperature of the furnace is raised in 1½ hr. to 1550 deg. F., the rods soaked for 15 min. at this degree of heat and quenched in the same manner as above.

They are again drained while yet warm, and placed on loops and charged into the furnace for the third or tempering heat. The temperature of the furnace is brought to 1100 deg. F. in one hour, and the rods soaked at this degree of heat for one hour. They are then removed from the furnace the same as for quenching, but are dumped onto steel platforms instead of into the the quenching oil, and are allowed to cool on these steel platforms down to the room temperature.

The forgings are pickled in a hot solution of either niter cake or sulphuric acid and water at a temperature of 170 deg. F., and using a solution of about 25 per cent. The solution is maintained at a constant point by taking hydrometer readings two or three times a day maintain-

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ing a reading of about 1175. Sixty forked or one hundred single rods are placed in wooden racks and immersed in a lead-lined vat 30 x 30 x 5 ft. long. The rack is lowered or lifted by means of an air hoist and the rods are allowed to stay in solution from one-half to one hour depending on the amount of scale. The rods are then swung and lowered in the rack into rinsing vat of running hot water until all trace of the acid is removed.

The snagging operation, including grinding a spot for the Brinell test, is performed on a No. 30 Ransom grinding machine with 18 x 1¾ x 2-in. Norton wheel, grain 20, grade 0. This spot is then polished on a felt wheel.

The rod is next subjected to Brinell test, this being performed on hydraulic testing machines, shown in Fig. 4, manufactured by the Pittsburgh Instrument and Machine Co. and a Swedish firm. These machines show whether or not the rod has been heat-treated to the proper hardness. If the rods do not read between 241 and 277, they are re-treated until the proper hardness is obtained.

The test lugs on the side and end of rod are first notched on a Whitney No. 6 hand milling machine, using a 60-deg. angular left-hand 2¼ x 1¼ x ¼-in. cutter. Notching side lugs, one man can handle 125 rods an hour and 75 rods for the end notching. The lug is then broken off on a Bliss No. 18 punch press with a V-shaped hammer, one man handling 125 rods per hour.

The grain is then inspected to determine if the rod has been treated properly, and is here subjected to the Government Inspection Metallurgical Department. After the test lug is removed, the surface is ground smooth by use of the wheel previously used for snagging.

Before beginning the machining operations the rod is tested in a fixture to determine straightness and centrality of fork with channel. This fixture consists of a cast-iron plate 12 x 24 x 1¼ in. that has two steel angle blocks fastened so that the rod channel rests on same, and one small angle block used to test the amount of stock on the piston-pin boss. The rod is laid on these blocks and held by hand while using templet that determines amount of material on inside as well as outside of fork. It is often found that the forgings require straightening and the forks either opened or closed. The channel is straightened by a screw press and the forks are either opened or closed by a wedge or by striking with a sledge on an anvil.

Grinding a Rear-Axle Housing

BY I. B. RICH

The rear-axle housing used by the Chandler Motor Co. is made of pressed steel in two parts which are afterward welded by the oxy-acetylene process. The surfaces which make the joints for both the differential case and the back cover are machined on a large grinding machine of the type built by the Diamond Machine Co., as shown in Fig. 1. The outer ends of the housing are previously ground in a large plain cylinder-grinding machine and these form the locating points for this facing operation. The ends are held in clamps *A* and *B*, while the angle plate *C* supports the center of the housing against the thrust of the grinding wheel.

A few passages of the housing past the cutting surface of the large cup wheel make a perfectly satisfactory joint on each side. A long bar gage placed across the ground surface and touching the cylindrical ends of the axle housing, shows when the work is within the desired limits.

The jig shown in Fig. 2 is used in drilling the holes for the clamping bolts on both sides of the housing.

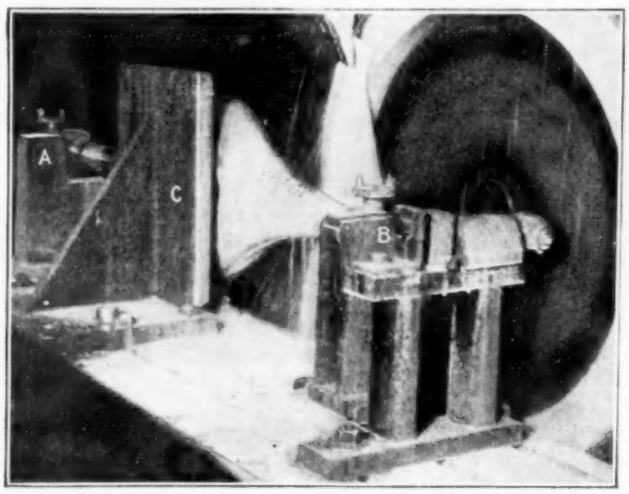


FIG. 1. GRINDING THE FACE OF THE HOUSING

FIG. 2. DRILLING THE BOLT HOLES

This is a revolving jig, the axle being carried in the trunnion shown. The upper half of the jig is hinged at *A* and *B*, the cover lifting out of the way so as to give free access for handling the work. The two halves are held together by the pin *C*.

Second Annual Aëronautical Exposition

The Manufacturers' Aircraft Association will hold its second annual Aëronautical Exposition at the Seventy-first Regiment Armory, 34th St. and Park Ave., New York, in March, 1920. Planes for private use, for sporting or touring purposes, or long-distance transportation of freight and mail will be on exhibition. Larger planes, carrying from 3,000 to 6,000 lb. and driven by three or four motors, will cover half the distance across the United States in a single flight.

Making Difficult Duplicate Gages

By Adolph Moses

On page 461, Vol. 51, under the above heading, E. A. Dixie expresses a strong desire for light upon several matters. He wants to be shown just how the accuracy of his gage, described on page 162, Vol. 50, was dependent upon a sharp edge.

This is most easily shown by supposing the plug to have been properly made and inserted in the ring. Examination under a microscope would have shown that the edge was never really sharp and that contact with the surface plate had still further reduced its keenness. The result is that the base diameter of the cone is not the same as that of the cylinder, but is smaller by an amount equal to double the thickness of the "edge." This is shown in the line drawing, Fig. 1, in which the dullness of the edge is exaggerated for clearness.

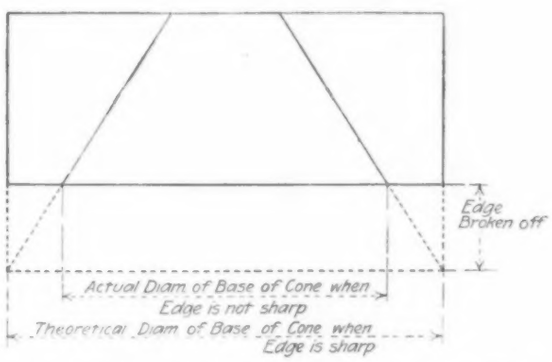


FIG. 1. EFFECT OF DULLNESS OF EDGE UPON ACCURATE MEASUREMENT

On page 1245, Vol. 50, under the pen name of B. A. Munson I have shown two other ways of making this gage. Mr. Dixie says that it seems to him that these measurements are also dependent upon sharp edges for their accuracy. If the line of contact between a cylinder or a cone and a plane surface is an edge, it certainly is news to me. As to the means of resetting the plug in the grinding machine, anyone who knows all about Hindoo mythology ought to know enough to grind the plug on centers—almost any ordinary two-handed man could then replace it so that it would run true.

Referring to the plug method of measuring, he questions the possibility of getting an accurate reading. If I am not mistaken I suggested the use of a size block in my original manuscript. However, if one holds the plugs down lightly with a finger on each, allowing the parallel surfaces of the micrometer spindle and anvil to line up the plugs, he will have no trouble in getting the measurement. By inverting the gage upon a surface plate as shown in the line drawing, Fig. 2, the conditions will be similar to those when measuring the pitch diameter of a screw thread with the aid of wires.

Again, he states that the making of a master gage to which a working gage is fitted is less accurate than the more direct method of making a working gage only. Most toolmakers know that if a plug is to go into a ring gage, it must be somewhat under the gage size, unless it is to be subjected to greater pressure than ought to be applied to a gage. By making a master gage, the necessary allowance for fit is automatically taken care of and does not introduce an error. It is a practical application of the ancient axiom that things equal to the same thing are equal to each other. When the scientist desires to obtain accurate weights, he uses the method of substitution, which is exactly what we are doing in the case of the master gage. Thus, strange as it may seem, it is possible to get more accurate results by making two weighings or two measurements than one.

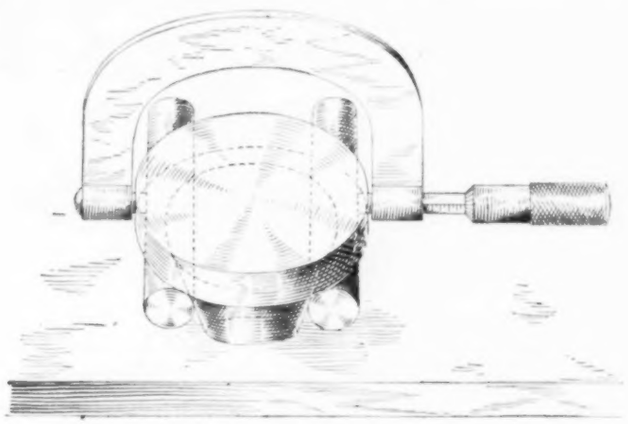


FIG. 2. MEASURING THE CONE BY MEANS OF PLUGS

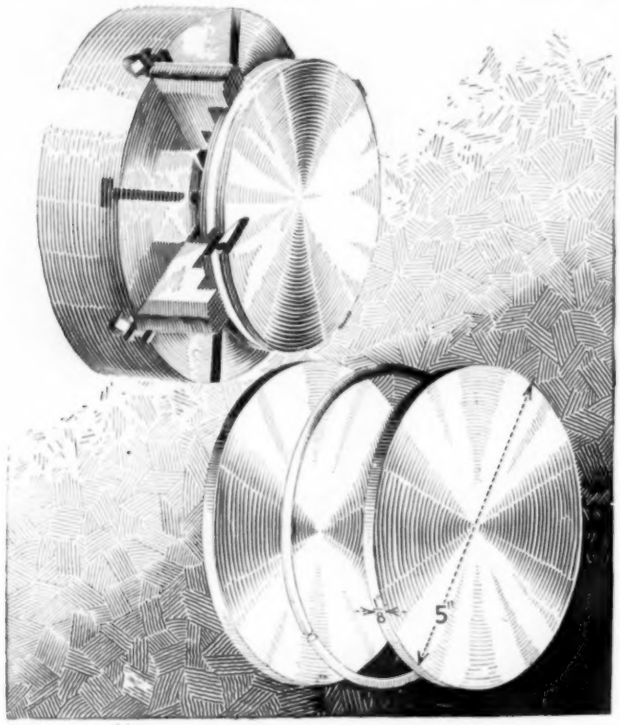
The ball method is probably the easiest and most direct way of measuring this gage. I have described it and given the necessary formula on page 706, Vol. 50.

Mr. Dixie thinks the gage must have been right or the work would not have been accepted. I would like to know how the inspection was made. Did he lend his gage to the inspector?

Quick Way to Make a Thin Disk

By Gustave Remacle

I recently had the job of turning two disks, 5 in. in diameter, from ⅛-in. cold-rolled flat stock. To hold the work I bent a piece of ⅛-in. round stock into a circle of about 4¾ in. in diameter, placed it between the two pieces



HOLDING A THIN DISK IN THE CHUCK

of flat stock which had been cut off, and sweated them all together as shown in the sketch. This permitted me to grip one piece in the chuck while the other was being turned; then reversing them, in the chuck, to turn the other.

Second-Hand Supplies That Cost the Foreman Nothing

By Peter F. O'Shea

In each supply stockroom of the Greenfield Tap and Die Corp., there is a separate part set aside for supplies which have been partly used and returned. Leather belts are sometimes taken off machines because they have been found too narrow or otherwise unsuitable, or because the machine has been moved to a new location and rigged in a different way. Such belts are still usable. They are therefore returned to the supply stockroom and put in the second-hand department. Pulleys, hangers, brackets and other shop supplies are likewise gathered.

When a foreman wants new supplies for his department he gets them only on requisition made in duplicate which goes to the office and has the price charged up against the monthly account of his department. But he can get the second-hand supplies by merely giving the clerk an informal memorandum, and then going in, looking over the available articles, and picking out what will serve his immediate purpose. Such goods have been paid for once and charged against the department which first ordered and partly used them.

In the bookkeeping of the shops, no attempt is made to set a value on the partly used goods. They are therefore not charged up against the foreman who is able to find a further use for them. Naturally, the foreman wants his comparative sheet at the end of the month to show up well, with as little charge for expense as possible. So he visits the second-hand shop first, before ordering anything new. This cuts down consumption, and uses up all the old supplies.

Every foreman is welcome to the articles in this stock, no matter what department returned them. No condition is made, except that each foreman and the maintenance department shall return to the supply stockroom all his own partly used material. Thus, the departments and the foremen's cupboards are not cluttered up with reserved supplies, for this material is all collected into a common pool, where the man who has the earliest use for it takes it. This multiplies, according to the number of foremen, the chance of its being used.

Another Way to Make a Pipe Center

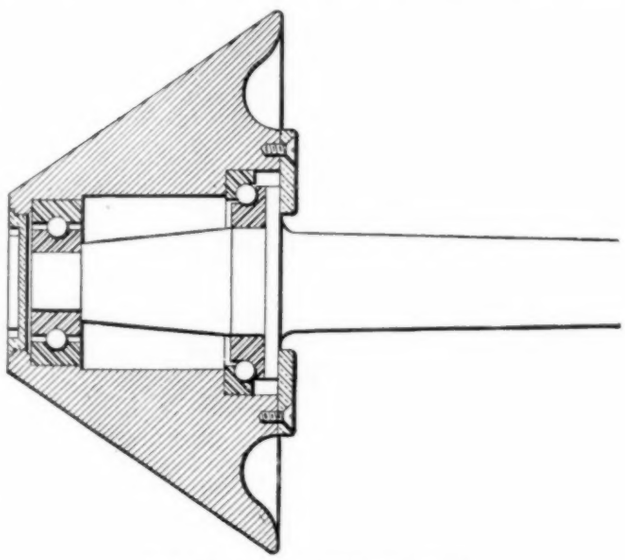
By T. W. Harrison

Balboa, Canal Zone

I notice on page 182, Vol. 51, *American Machinist*, a "better way to make a pipe center," and if I am not too late I have another. Herewith is a full-size drawing of one we made in 1915.

Although it cost more than the kind you find in most machine shops, this center has paid for itself several times over.

We have considerable heavy work requiring the use of a pipe center and I have found that the repairs were



BALL-BEARING PIPE CENTER

so great on the ordinary kind (several kinds), that I was forced to design something heavier not only for pipe work but for heavy, long bushings, etc.

At the same time we made two 16 in. in diameter of the same design and neither have had any repairs, though there is hardly a day passes that they are not in use.

The ball bearings and brass cap at the small end of the center are taken from our stock of pneumatic-tool spare parts.

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Modern Artillery Ammunition—II

By CAPT. H. M. BRAYTON, Ord. R. C.

This article comprises a study of some of the more important calculations involved in the design of modern artillery ammunition and a description of some of the more important developments during the war at the Frankford Arsenal.

IN a previous article the writer discussed powder pressures within the gun and the effects of this pressure in producing the force known as "set back" within the shell. Calculations were carried out showing how to determine this force under various conditions. While set back is one of the more important forces to be considered in the design of ammunition, it is by no means the only force produced or set up within the shell by the pressure of the propelling gases.

All guns, howitzers and nearly all mortars are rifled; that is, the interior of the bore is spirally grooved. A cross-section of a modern gun is shown in Fig. 4. The raised portions are called lands while the cut away parts are known as grooves. The grooves are much wider than the lands. This grooving of the interior of the bore is for the purpose of making the projectile rotate during flight. Rotation is necessary in order for the shell to carry properly in its trajectory. The rear of the shell is fitted with a copper rotating band which is cut into by the harder steel lands within the gun and forced to rotate on its way out of the bore. Of course, these grooves must be cut into the interior of the bore in the form of a spiral, otherwise the shell would not rotate. In American practice, guns are rifled in a clockwise direction as viewed from the rear; that is, the shell will be forced to rotate in a right-handed direction when forced from the bore by the pressure of the burning powder. Foreign practice is in most cases directly opposite from this as most of their guns are rifled in a counter-clockwise direction when viewed from the rear. No particular arguments can be advanced for either of these two systems as both are equally good and it really makes no difference in which direction the gun is rifled.

To the technical man it will be evident that the forces set up within a shell by this sudden rotation are enormous. A heavy shell at rest within the bore of the gun is in an extremely short interval of time ejected from the muzzle and brought up to its full rotation which may amount to from a few thousand up to over 20,000 revolutions per minute, depending upon the type of gun or howitzer. Let us take a concrete illustration, using the standard American 3-in. field piece. The projectile will weigh 15 lb. and the interior length of the bore or travel of the projectile is approximately 28 calibers or 84 in. The muzzle rotation is 17,000 per minute and the muzzle linear velocity about 1700 ft. per second. This linear velocity varies, of course, from zero at the start to its maximum value at the muzzle but if we assume the average value of the velocity to be around 800 ft. per second, which is very close to what it actually is, we can determine that the shell is in the bore of the gun only about 0.008 second. Yet, in this extremely short interval, the shell must be accelerated and brought up to both its linear and rotational speeds. This can mean nothing less than very great resulting inertia forces.

It would naturally be our first thought that the rifling should be cut along some curve that would be easy to reproduce and also one that would reduce the angular inertia forces to a minimum. Much thought has been put into this phase of gun design. The end to be attained, namely, higher pressures and lower stresses in the shell, warranted the spending of much time and money in the finding of a suitable solution.

The simplest of all rifling is one in which the spiral is uniform and it was but natural that men turned to that form when they first began to rifle guns. It was simple, easy to machine, and it served the purpose when powder pressures were low and ammunition consisted of less complicated mechanisms than is true at the present day. A diagram of uniform spiral rifling is shown in Fig. 5. This means that if one of the lands could be taken out and straightened it would form a straight line as shown in the sketch. This line would at all times be inclined to the axis of the gun the same as shown on the plot. This inclination is known as the slope of the rifling and upon its value depends the final value of the rotation of the shell. When drawn through, the origin as shown its equation becomes simply $Y = mX$; where m denotes the slope of the line or $m = \frac{dY}{dX}$. The slope is then constant and the second derivative or the rate of change of the slope is zero. This means that the shell is given just as much of an angular twist when it first starts on its outward path as it gets at the muzzle. It will be recalled from the previous article

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that the pressure curve reaches its maximum near the breech. The linear acceleration was shown to be a direct function of the pressure, hence also reaching its maximum value at the same point. It will be shown later that a definite relation exists between the slope of the rifling curve, the linear acceleration and the angular acceleration. This angular acceleration will reach its maximum value at the point of maximum pressure and maximum linear acceleration when the slope of the rifling is constant as in the case cited. It will readily be appreciated that it is not good design to have all of these forces reach a maximum value at the same point. The linear relation existing between the pressure and the linear acceleration makes it impossible to separate these two but in the case of the angular acceleration the slope of the curve enters.

As time went on and knowledge of machine-shop methods increased, a more complicated form of curve was introduced for the rifling. This was the parabola shown in Fig. 6, the equation of which is given by

$$Y = mX^2 \tag{8}$$

the first derivative or slope by

$$\frac{dY}{dX} = 2\,mX = \text{slope} \tag{9}$$

and the second derivative or rate of change of slope by

$$\frac{d^2y}{dX^2} = 2m \tag{10}$$

It can be seen from the slope equation that the greater the value of X, that is, the farther out toward the muzzle, the greater is the value of the slope. With small values of X or up near the breech where the pressure and linear acceleration are a maximum we have a low value for the slope. This is exactly the result desired and results in a much lower angular acceleration and correspondingly lower angular inertia forces.

But men were not contented with the results given by this form of curve and so the ordnance experts set about finding something a little better. After much experimentation and study a curve known as the semi-cubical parabola was adopted. This curve is given by the equation

$$X^{\frac{3}{2}} = 2\ PY \tag{11}$$

and is plotted in Fig. 7. The first derivative or slope is given by

$$\frac{dY}{dX} = \frac{3\sqrt{X}}{4P} \tag{12}$$

and the second derivative or rate of change of slope by

$$\frac{d^2Y}{dX^2} = \frac{3}{8\,P\sqrt{X}} \tag{13}$$

This curve is used almost exclusively in the rifling of modern guns and howitzers and for this reason further discussing will be warranted in order to make clear to the designer of ammunition just how to use it in determining the forces resulting from rotation and angular acceleration.

The Ordnance Department of the Army publishes a "Cannon Data Book" which contains all sorts of data of value to the designer. Among this data is given the rifling used on the various guns, showing the slope of the rifling curve at the muzzle and at the breech in case these two values are different. Take for an illustration the standard 3-in. field gun. The data book states that the slope of the curve is 1 in 25 at the muzzle and 1 in 50 at the breech. This means that the slope of the curve at the muzzle is 1 in 25 calibers, or, in other words, that the shell will make one complete turn in traveling a linear distance of 75 in. This would be true if the ratio of 25 to 1 held throughout the bore which it does not because at the breech the slope is only 1 in 50. With this information it is possible to determine the equation of the curve as follows:

$$\text{Slope} = \frac{dY}{dX} = \frac{3\sqrt{X}}{4P} \tag{12}$$

Let X_1 = the point on the curve at the breech of the gun;

X_2 = the point on the curve at the muzzle.

Then $X_2 = X_1 +$ length of gun in inches $= X_1 + 84$.

$$\text{Slope of curve at muzzle} = \frac{3\sqrt{\ }}{3 \times 25} = \frac{\sqrt{\ }}{25} \tag{14}$$

$$\text{Slope at breech} = \frac{\sqrt{\ }}{50} \tag{15}$$

We may then write

$$\frac{3\sqrt{X_1}}{4P} = \frac{\sqrt{\ }}{50} \tag{16}$$

$$\frac{3\sqrt{X_2}}{4P} = \frac{\sqrt{\ }}{25} = \frac{3\sqrt{(X_1 + 84)}}{4P} \tag{17}$$

Solving these two equations for the value of P, we find it equal to 63. We then have $X_1 = 28$, $X_2 = 112$. The equation then becomes

$$X^{\frac{3}{2}} = 126\ Y \tag{18}$$

and the rifling at the breech starts on this curve at X = 28 in. and ends at X = 112 in. From the equation in this form we may find both the slope at any point and the angular acceleration.

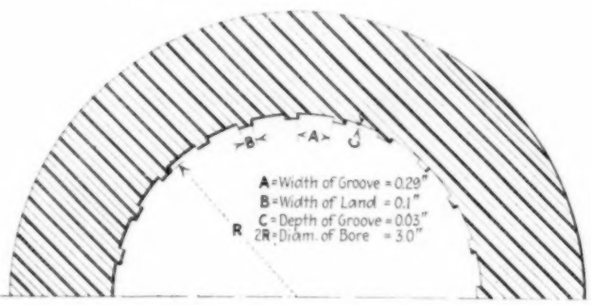

FIG. 1. CROSS-SECTION OF 3-IN. GUN NEAR THE MUZZLE

This form of rifling offers somewhat more resistance to the passage of the shell through the gun due to the fact that the rifling is compelled to cut a new path for itself in the rotating band throughout the entire bore. This is shown in the second derivative where the rate of change varies inversely as the square root of the distance. This increase in passive resistance, as it is called, is not of sufficient importance to be worthy of further discussion.

It was shown in a previous article that the pressure in the gun acting on the projectile caused the linear acceleration. In the same way a combination of this lin-

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ear acceleration and the rifling causes the angular acceleration. The forces set up in the shell due to this sudden twist seem to be very vague to most men and it is common practice for designers to ignore these stresses due not to their insignificance, for they are very real and often large, but rather to a lack of knowledge of the simple mathematics involved. Rather than master this technical side of the problem, many designers and manufacturers have preferred to build their fuse or their shell along the cut-and-try method, trusting to luck that their devices would in some mysterious way work as it was desired to have them. The inevitable result under these conditions is complete failure and it will indeed be fortunate if no accident happens during the experimental tests.

The angular acceleration is obtained from the linear by simply multiplying the linear by the slope of the curve, all expressed in proper units. An illustration will make this clear. Let us suppose the linear acceleration equals 500,000 ft. per second, per second, and that the slope of the rifling curve equals 1 in 50 calibers or $\frac{\pi}{50}$. We may then write for the 3-in. gun

$$\alpha' = \text{angular acceleration} = \frac{500{,}000\,\frac{\pi}{50}}{\frac{3\pi}{12}} = \frac{500{,}000 \times 12}{3 \times 50} = 40{,}000 \qquad (19)$$

This α' is expressed in revolutions per second, per second. If we desire it in radians per second, per second, we must, of course, multiply by 2π.

In the same manner, the value of this acceleration may be found at any point from the breech to the muzzle when the linear acceleration curve is known.

Whenever we have acceleration we must have inertia forces. This holds true in angular as well as in linear acceleration. In the case of the latter we have the force of set back produced, while with the former we get a torque or twisting action. This torque must be expressed as a moment and may be obtained from the following formula:

$$\text{Torque} = \frac{\alpha I}{12\,g} \qquad (20)$$

Where torque is expressed in inch-pounds, $g = 32.2$; I = the polar moment of inertia of the shell, and α = the angular acceleration at the point in the gun that is under discussion or, which is more usual, the maximum value expressed in radians per second, per second. If the maximum value of the torque is known, it is usually sufficient for most practical purposes in the determination of the results of this moment on the parts of the design. It must be remembered, however, that this maximum value of the torque does not necessarily occur at the point of maximum pressure. It only occurs at this point in guns having the uniform rifling curve. The actual point of greatest angular stress comes slightly ahead of the point of greatest pressure; but for all practical uses it is sufficient to calculate it at the latter place as the difference is slight and the pressure curve is not always known for every gun when using the various grades of powder. It is a simple matter, as shown in equation 19, to get the value of α at this point if one has the standard data of the gun being considered.

Coming back to equation 20, we have as a factor the polar moment of inertia I. This quantity would be difficult to obtain exactly due to the peculiar shape of the shell. For most practical work we may, without appreciable error, consider the projectile as a hollow cylinder. The value of I is then found from the well-known formula

$$I = \frac{W(r^2 + r^2{}_1)}{2} \qquad (21)$$

where

W = weight of the shell in pounds;
r = outside radius of shell, inches;
r_1 = inside radius of shell, inches;
I = polar moment of inertia in inch units.

Formula 20 may be combined with 21 and we then have

$$T = \frac{\alpha\, W(r^2 + r^2{}_1)}{24g} \qquad (22)$$

Application of Formulas

Thus far nothing has been said in regard to the use of these formulas in the determination of the forces set up in the shell due to angular acceleration. Let us suppose we have designed a fuse to be used in a high-powered gun. We have already calculated the force of set back on all of the parts and designed them to withstand this tremendous force. It might well happen, however, that the fuse was well protected from the set back force but wholly unprotected from the angular. As is well known all parts have inertia due to their weight. When the shell is rapidly accelerated and the angular torque occurs, the part upon which we desire to know the stresses will set back just as it did in the case of the linear acceleration except that this time it tends to move in a plane perpendicular to the axis of the shell and in a direction opposite to the direction of rotation. Of course, as a rule the part does not actually move or rotate backward as it may be held by other metal parts but in this case the metal must take up the stress as it did in the case of the longitudinal force.

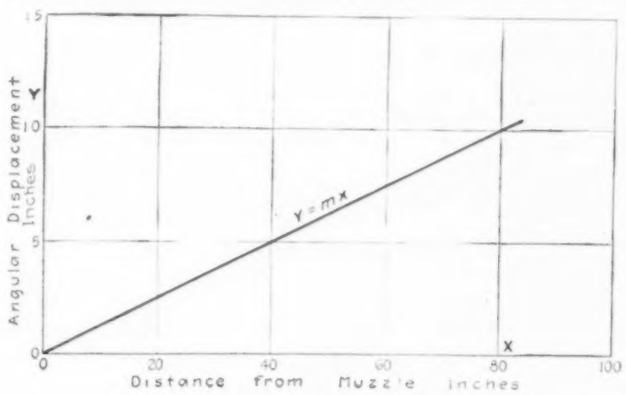

FIG. 5. LINE OF UNIFORM RIFLING

Probably the most direct way of obtaining the angular set back is to transfer the angular acceleration into terms of linear acceleration for the point off-center

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which represents the center of gravity of the mass we are considering. An example will perhaps be best to make all this clear. Let us assume that the fuse contains a part one inch off-center and that this part weighs half an ounce. We have found from equation 19 the value of α for the whole shell. This value will be expressed in revolutions per second, per second. What then is the linear acceleration of the center of the mass which is one inch off center? Simply

$$a = \frac{2\pi R\alpha'}{12} \qquad (23)$$

Where a = linear acceleration of the point in feet per second, per second;
R = distance off-center in inches;
α' = angular acceleration of the shell in revolution, per second, per second and found from formula 19.

With the value of the linear acceleration known, it is simply a matter of applying the linear inertia law to get the set back. This was given in equation 3 in a previous article as follows:

$$F' = \frac{W'a}{g}$$

Where F' = total set back in pounds;
W' = weight of part in pounds.

In our example we have

R = 1 inch;
α' = 40,000 revolutions per second, per second;
$W' = \frac{1}{32}$ pounds.

With these specific values we obtain

$$a = \frac{2\pi 1 \times 40{,}000}{12} = 21{,}000 \text{ feet per second, per second.}$$

$$F' = \frac{21{,}000}{32 \times g} = 20.4 \text{ pounds.}$$

This simply means that our part which weighs only half an ounce and is but one inch off-center sets back against its supports with a force of over 20 pounds. If calculated further in terms of unit area and pounds per square inch compression, it would undoubtedly exceed the elastic limit of the metal. This is a very vital point to consider in all design work in this field and its neglect will account for a large number of the failures. The metal may deform under this force in such a way that it can not properly perform its function later on when called upon to do so.

This twisting moment is often the cause of time-rings turning relative to the body of the fuse, thus causing short or long burnings. The friction caused by the linear set back, however, tends to keep the ring from turning and is usually sufficient to do so. It is a factor of sufficient importance, nevertheless, to have caused some fuse designers to incorporate a locking device on the fuse. This first appeared in foreign designs and has not yet been universally adopted on American fuses.

Generally speaking, inertia forces due to angular acceleration are a detriment and their results must be guarded against by scientific designing and calculation of all the forces. Such procedure will save much time and money and a more satisfactory product will be produced. The safety factor also enters in here because it may well happen that the fuse is made unsafe by the failure of some part to withstand the stresses brought to bear upon it. Failure of the detonator carrier, for example, might explode the detonator and thereby the shell, prematurely wrecking the gun and perhaps doing serious injury to the gun crew.

Centrifugal force probably causes the designer more trouble and interferes more with his plans than all of the other forces with which he has to deal put together. Practically everyone who is at all technically inclined knows what this force is, how it acts and what produces it; yet it was noted that a large number of technical men presented new designs to the Government for consideration in which the effects of centrifugal force had been entirely neglected. In many cases, the designer was wholly ignorant that such a force was present and in others it was known but not considered of sufficient importance to calculate. This lack of the fundamental principles of shell and fuse design caused the failure of many men's dreams in the quest for new things to revolutionize warfare.

The principle is simple. Everyone knows that if we fasten a weight on a string and revolve it while retaining hold of the other end that the weight will continue around in a circular path and will create a very noticeable tug on the string. If the string is released the weight flies off at a tangent showing that a force was actually present. We have the same condition within a shell. As previously stated the shell is brought up to a very high rotational speed within the gun due to the rifling. This rotation sets up centrifugal force and this force exists everywhere within the projectile. All parts tend to move toward the outside and if prevented from so doing by adjacent parts a very great stress is created just the same as the force created in the string when the weight is forced to travel in the circle.

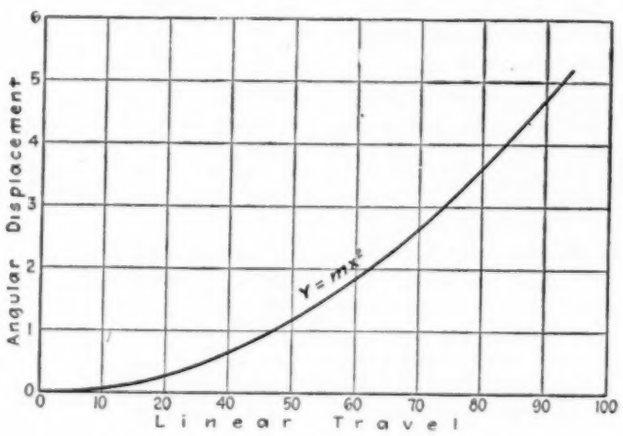

FIG. 6. PARABOLIC CURVE OF RIFLING

Fortunately for the science of gunnery, this centrifugal force is easily calculated. It is also possible to obtain its value with mathematical exactness. The fundamental formula is as follows:

$$C.F. = \frac{MV^2}{R} \qquad (24)$$

Where $C.F.$ = centrifugal force in pounds;
M = mass of part under consideration in pounds;
V = linear velocity in feet per second;
R = distance of part from center of rotation in feet.

In this form the formula is not always convenient for use in fuse designing. We usually know the radius of the part in inches, the weight of the part in pounds, ounces or grains and the rotation of the shell at the muzzle of the gun in revolutions per minute. We may readily transform this equation to meet the needs of these units. The following calculations will be self-evident:

$$M = \frac{W}{g}$$

$$V = 2\,\pi\,RN$$

$$R' = 12\,R$$

Where W = weight of part in pounds;
R' = distance of part off-center in inches;
N = speed of shell in revolutions per second.
We may then write

$$C.F. = \frac{MV^2}{R} = \frac{W\,(2\pi RN)^2}{gR} = 1.23\,WRN^2 \qquad (25)$$

Here N = rotation in revolutions per second.

Generally, however, it is not convenient to express N in second terms, R in feet and W in pounds. The parts under consideration generally are smaller and we find it best to express W in grains, R in inches and N in revolutions per minute. This last unit is preferable because it is customary to give the rotation of shell in this way. With these units we may write equation 25 as follows:

$$C.F. = \frac{1.23\,W'R'(N')^2}{7000 \times 12 \times (60)^2} \qquad (26)$$

In which W' = weight of part in grains (7000 grains = 1 pound);
R' = radius in inches;
N' = rotation of shell in r.p.m.
This may, of course, be reduced to one constant when we have

$$C.F. = 0.000,000,004,070\;W'\;R'\;N'^2 \qquad (27)$$

Equation 27 is a practical formula which may be easily applied in determining this force. As an illustration, let us assume that in the fuse we are designing there is a metal part half an inch off the center of rotation or axis of the shell. This part weighs 200 grains which is slightly less than half an ounce. We are designing our fuse for the American 3-in. field gun or the French 75-mm. field piece. The muzzle rotation of the shell in these guns is practically 17,000 r.p.m. By applying the formula given in equation 27 we have $C.F. = 0.000,000,004,070 \times 200 \times 0.5 \times (17,000)^2 =$ 117.5 lb. This illustration will give an idea of how large this force really is and how vital a factor it really becomes in the design of modern ammunition.

Some men are not accustomed to dealing in grains as a unit of weight and for those we will write the formula in terms of the ounce as the unit as follows:

$W = \frac{W''}{16}$ Where W'' = Weight in ounces

Then $C.F. = 0.000,001,785\;W''\;R'\;N'^2$ (28)

This force is different from the forces due to inertia described in the previous sections. While they last only as long as the shell remains in the bore, a very short interval, the centrifugal force is present during the whole flight of the projectile. It varies in the gun from zero at the breech to its maximum at the muzzle and remains fairly constant during flight, as the rotation decreases but slightly while the shell is traveling to its target. The air friction, which is small, is the only force tending to slow down the rotation. Centrifugal force is then always present during the flight of the shell. Fuses designed to function upon impact are affected by it because it is almost certain to be present during the whole time that the shell is penetrating its target and functioning.

The effects of this force are by no means confined to the stresses which it produces in the various parts.

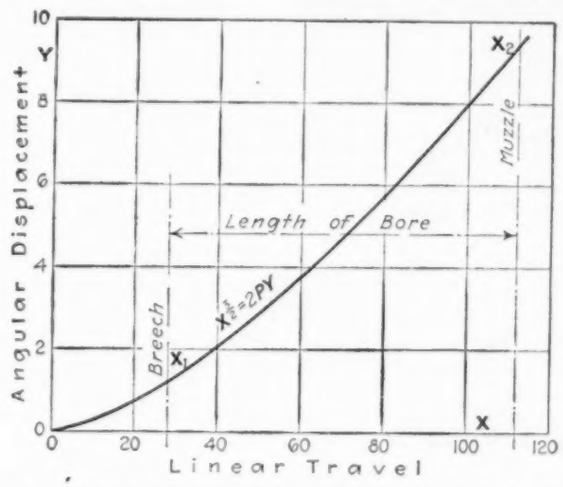

FIG. 7. CURVE OF RIFLING—SEMI-CUBICAL PARABOLA

Force properly applied always produces friction in moving parts. We have here an excellent illustration of this principle. If we attempt to move a part within the fuse while it is rotating by means of a spring, for example, we find that considerable force is necessary. If sufficient force is not applied we find that the part will not move. This is according to the simple law of friction; yet many designers, even of the higher type, failed utterly to apply this law to their designs. These statements apply with special emphasis to the attempt which has been and is still being made to develop a mechanical time fuse to take the place of the powder train method of obtaining the time of explosion. In the mechanical time fuse we have a complicated arrangement of gears, wheels, springs, etc., arranged much the same as in an ordinary watch. The mechanism must, of course, run and function during the flight of the shell and thus during the time that the centrifugal force is at its maximum. A large amount of friction is created in the bearings and those parts upon which other parts move and is often more than sufficient to prevent the clock from running. This was one of the great difficulties encountered in the early development work in this line and delayed the progress a great deal. Most of this development work was

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carried out by the watch and clock companies because they were better equipped to carry it through to a successful conclusion. Continual failure was encountered mostly because the watch companies neglected to analyze the forces existing within a shell in flight. Centrifugal force was the most troublesome of all but when properly considered its disastrous affects *per se* were found to be more imaginary than real. As an illustration, one watch concern that had been blessed with continual failures for over a year decided that something radical must be done at once if it were ever to get results. It consequently sent some of its fuses to an Army arsenal where a ballistic engineer analyzed the problem. After careful study it was found that a certain wheel which was carried on a shaft parallel to the axis of the shell and placed about ¼ in. off-center would stop rotating under the action of the mainspring when a weight of two ounces was hung on the shaft. The wheel and shaft were carefully weighed and the centrifugal force calculated for the gun from which the fuse was to be fired. Much to the surprise of the designers, and perhaps to the engineer as well, it was found that this shaft had a force of over two pounds acting on it in a radial direction during flight. This was more than 16 times the force actually required to stop the whole mechanism.

Centrifugal Force Helps the Designer

Heretofore, we have mentioned only the undesirable aspects of centrifugal force. It fortunately has its good qualities. It is the one force next in importance to set back in the designer's field. Without it we could not have the superhuman devices which we have today in modern ammunition. By its absence in bodies at rest, shells are made safe in handling and in storage. This is accomplished by making it necessary for the shell to receive a high rotation before it is armed or in position to fire. This arming is accomplished by utilizing centrifugal force in many different ways, usually by causing weights to fly out and thereby exposing the firing pin so that it can come in contact with the primer when the shell meets resistance.

To calculate the force necessary to overcome friction created by centrifugal force it is only necessary to multiply the force by the coefficient of friction. A value for this coefficient for the surfaces under consideration may be found in any engineering handbook. Where the two surfaces are steel a good value to use and one which has been found to work out well in practice is 0.2. If the surfaces are smooth it may be advisable to reduce this value to 0.15 although the former value will be found more nearly correct in most cases. What does this mean then? Simply this—if you have a part off-center in a shell and desire to move it during the flight of the projectile, you must apply a force to it equal to the product of the centrifugal force and the coefficient of friction. This is only one of the laws of friction and holds good within a shell just as well as it does anywhere else. One fact must be well fixed in mind and that is that the friction is absolutely independent of the area. More people go astray on this than any other one thing connected with the determination of the friction forces. It is not at all uncommon to find a designer attempting to reduce his friction and friction moments by reducing the area of contact. As a matter of fact this neither reduces nor increases the force. It varies the intensity of stress to be sure but not the friction. The only way to reduce this effect is to reduce the centrifugal force and this is done by making all parts as light as possible and placing them as near the center of rotation as is practicable.

At this point the centrifugal force in the shell while the latter is within the gun may be noted. It was shown previously that the rotation starting at zero at the breech gradually reached its maximum at the muzzle. As the centrifugal force varies as the square of the rotation it will readily be appreciated that this force gradually increases as the shell travels outward, reaching its greatest value at the muzzle but practically retaining it throughout flight. This has a bearing in the design of fuses, for example, and is often utilized. This means that when the two inertia forces are a maximum the centrifugal force is a minimum and vice versa. Great care must be exercised in designing a device that will arm the shell on rotation to safeguard it from arming before it has left the gun and before the effects of the set back have disappeared. If the device does arm before it should, it is almost certain that the shell will explode either just as it leaves the gun or just before. In the latter case the end of the gun will be blown away if the shell happens to be a high-explosive one. These facts coupled with others have led to the development of "bore safety" features on fuses.

The principal forces acting on a shell while in the bore of a gun are first the linear set back, a force which is great in magnitude, always present and which varies from zero at the breech to a maximum in a distance of a very few inches and then gradually drops off to zero about 10 ft. outside the muzzle. This force may be used as the designer sees fit in releasing catches that control the firing of primers by forcing them down on to the firing pin, as is done in the ordinary powder time fuse, or in any one of many different ways in which this force is now used. On the other hand every part must be calculated to withstand this force; otherwise it will be crushed in the gun and unable to perform its function. Then we have the angular acceleration as a result of the linear acceleration and the rifling. It was shown that this force acted in a plane perpendicular to the axis of rotation of the shell which makes its line of action 90 deg. from the linear set back. It was pointed out that this force reached its maximum at about the same point as the linear but that it became zero exactly at the muzzle instead of outside. This was due to the ending of the rifling. Then lastly it has been shown how to calculate centrifugal force and how to overcome it when it is excessive. It was further shown that this force, while it acted in a plane perpendicular to the axis of rotation just as the angular acceleration was, nevertheless, quite different in that it started from zero at the breech and reached a maximum at the muzzle. Centrifugal force always acts, of course, in a strictly radial direction, while the angular inertia force always acts perpendicular to this direction of the tangent to the plane of rotation. This

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makes the angular force at right angles to the centrifugal force but in the same plane.

It will be apparent then that we have these three forces acting on the parts within a shell all at once in varying degrees. For any one point within the gun it is possible to calculate each one separately and combine them vectorially and get their resultant. This is the only true way to determine the stress on the parts and it should be carried out for several points along the bore in order to determine the maximum value. It is a simple matter to combine them as the three really act in three planes at right angles to each other. The position of the resultant will depend on the relative values of the three forces. If calculation is carried out in this way on every part of the device and each part is designed to perform its proper function under those conditions, the designer need have no fear of the results in practical firing tests.

The question of the determination of the pressure curve in any given gun has not been taken up here. This subject will be found fully treated in any of the many books on the subject of ordnance and gunnery. The determination of this curve is, of course, fundamental because without the information which it gives, none of the calculation carried out above could be accomplished. This curve may be determined in two ways: by experimental firings or by calculation. The former method is costly but apt to be the more accurate. The method of calculations will suffice for most purposes. This determination involves such factors as the character and weight of the powder, the size and shape of the grain, the volume of the powder chamber, the caliber of the gun, the temperature of the powder at time of firing and above all on the weight of the shell. The greater the weight of the projectile the higher the pressure curve will go—all other factors remaining the same. The density of loading is the ratio between the weight of powder used in the charge to the weight of water which will just fill the powder chamber. This value naturally varies greatly in the different guns and howitzers and will range all the way from 0.7 to 0.3. In a few exceptional cases it reaches 0.8 but this is not usual. The higher the value of this ratio the greater will be the pressure in the gun.

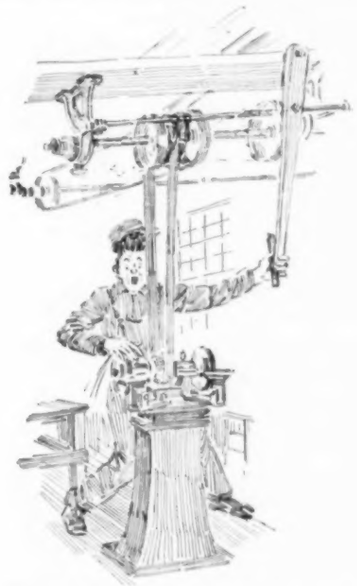
It is not unusual in practice to use an excess charge of powder. This results, of course, in excess pressure and greater muzzle velocity of shell. The objects to be attained in the use of excess pressure are twofold: first to test the strength of a gun or the durability of ammunition and, second, to increase the muzzle velocity and thereby the range of the shell. This excess pressure is seldom carried beyond 12½ per cent. of the normal pressure. In old guns no excess pressure is allowed. Fuses and other parts of ammunition are often calculated upon the basis of the excess-pressure curve rather than on the normal so as to insure perfect operation under all tests to which the proving-ground officers will subject them when presented for trial. Some nice problems arise when it becomes necessary to use shells which are not standard weight or when it is desirable to change the powder charge from the normal. These questions need not bother the average designer as they need to be considered only when conditions are abnormal.

If the civilian engineer who wishes to submit a design to the Ordnance Department of the Army for consideration will first calculate the stresses within his mechanism according to the above outline his serious difficulties will disappear.

Braking a Grinding Wheel by Hand

By Harry Senior

During the war we, like all other employers of skilled labor in any way relating to the machine business, were afflicted with all sorts and conditions of machinists who came from "road and river—countryside and town," and ranged from fellows who modestly admitted that they had "fixed dad's mowing machine," to those



who "could do any job in the shop," and wanted all the money there was in sight.

One day one young fellow, whose entire previous mechanical experience had been acquired behind the ribbon counter of the local dry-goods store, came to me with a very bad looking hand. Diagonally across the palm was an ugly bleeding wound that was part blister, part cut, and part tear.

"For the love of Mike!" I ejaculated, "what have you been trying to do; get your hand in by grinding it?"

"Just stopping the emery wheel quick, like Bill does," was the reply.

"Bill" was an old and tried jour, who, I was perfectly certain, had never attempted to stop a grinding wheel by braking it with his hand—at least not in a good many years; so after dressing the boy's hand we went over to interview Bill.

"What do you think I am! Nutty?" casually inquired Bill upon hearing the boy's story.

"Saw you do it only a few minutes ago," said the boy, "right over here"; and he led us over to the speed lathe and showed us how Bill had stopped that machine quickly, after shipping the belt off, by pressing his hand on the large step of the smooth iron cone.

EDITORIALS

The President's Industrial Conference

WE ARE all interested in the object of the conference which is to avert or postpone industrial conflicts. And as it is the desire of the conference to have the careful consideration of all interested individuals or organizations, we give an outline of the points so far brought out.

The conference is not seeking the causes of industrial unrest, but rather the best methods of preventing or adjusting disputes. It emphasizes the importance of considering the human element in the belief that the successful industrial organization must yield a large satisfaction in the life of the individual. It contends that the industrial world has failed to adjust human relations to the facts of our economic interdependence.

The conference points out that the relationships in modern business must be organized on a sound basis, with a sincere effort for mutual understanding and with the employers as leaders rather than as masters.

It is proposed to establish a national tribunal and regional boards for inquiry and adjustment of disputes, the country being divided into twelve or more industrial districts. The national tribunal is to have headquarters in Washington and is to be composed of nine men, three representing employers, three representing employees and three representing the public. The Secretary of Labor will nominate the employee representatives, the Secretary of Commerce those for the employers and the President will choose the members representing the public.

The regional boards consist of a chairman who is to represent the public interest and to be appointed by the President, two employees and two employers. The board must publish its report within five days of the close of the hearing and within thirty days from the date of original request. If the reports are not unanimous both majority and minority reports must be published. The regional boards have the right to subpoena witnesses, examine them under oath, require production of pertinent books and papers and to insure protection to witnesses. Whenever agreement is reached or decision made it shall have the force of a trade agreement.

The conference is undertaking a gigantic task in the hope of securing national co-ordination and stimulating the formation of bodies for local adjustments. It will not and cannot formulate plans which will suit everyone nor which will work perfectly at all times; they are bound to be too conservative for some and too radical for others.

It is the part of wisdom to support the conference as far as possible to show our good faith in desiring an end to industrial disputes. Both sides must concede something in nearly all settlements and we should be willing to go halfway in meeting changes which are in the line of evolution and progress. If means are provided to prevent strikes or lockouts until the dispute has been passed on by the regional board we shall have made a long step forward.

The Foreman and His Job

THE foreman's job has changed greatly since the days of the old shop. Then, he was the instructor, guide, counselor—almost the father confessor—of the whole shop. When the shop began to grow larger, the foreman's job changed according to the size of the shop and the kind of management. The management which prided itself on cold-blooded efficiency and proclaimed the motto that there must be no sentiment in business, developed the bull-dog type of foreman. In other shops the foreman became simply a timekeeping clerk, handing out various jobs as they came from the planning department. The shops which have suceeded best from every point of view, however, are those which retained the human side and realized that the personal element played a large part in manufacturing.

The job of foreman should not be that of a buffer, standing as a wall between the management and the men, and taking blows from both sides. Such a position is most unhappy from every point of view. A foreman of this kind is under suspicion from both sides and is often ostracized in the social life of the community.

The modern foreman should rather be a representative or interpreter of both sides. He should thoroughly understand the policies of the management and be able to explain their workings to the men. On the other hand, he should be able to interpret to the management the attitude of the men on all questions, and his opinion and friendly criticism should not be suppressed, but should be sought by both the management and the men.

Perhaps the first requisite of a good foreman who is to retain his self-respect is loyalty—loyalty to his *job*.

If the men insist on acting unfairly to the management or make unreasonable demands, he must notify them that loyalty to his job compels him to side with the management. If the management refuses to act fairly toward the men, loyalty to the job of foreman demands that he look for employment elsewhere. He should not feel obliged to uphold unfair tactics, but when he finds he cannot be loyal to the management he should lose no time in severing his connection with that company.

The foreman who is to be really successful, who is to grow out of the job into one of larger opportunities, must be above petty jealousies of any kind. He should encourage suggestions from his men, as this is one of the many ways of increasing production. The foreman who frowns on such suggestions, will never get very far up the ladder.

Some of the most successful foremen and higher executives have won their success by gathering around them the most capable men possible. They have encouraged suggestions and have given credit freely in all cases. The foreman who attempts to appropriate the ideas of his men for his own advancement rarely gains anything by so doing. The foreman must learn that it is team work of the whole department which counts, and that unless he can secure the hearty co-operation of his men he cannot hope to make a very creditable showing.

SHOP EQUIPMENT NEWS

-Edited By-
E. L. DUNN and S. A. HAND

SHOP EQUIPMENT • NEWS •
A weekly review of modern designs and • equipment •

Descriptions of shop equipment in this section constitute editorial service for which there is no charge. To be eligible for presentation, the article must not have been on the market more than six months and must not have been advertised in this or any previous issue. Owing to the news character of these descriptions it will be impossible to submit them to the manufacturer for approval.

• CONDENSED • CLIPPING INDEX
A continuous record of modern designs • and equipment •

Toledo Drawing and Stamping Press

The Toledo Machine and Tool Co., Toledo, Ohio, has added to its line a series of double-crank, toggle, drawing- and deep-stamping presses, the smallest one being illustrated herewith.

It is claimed by the maker that the presses in this series embody all the most modern ideas in presses particularly adapted for the manufacture of automobile bodies, fenders, hoods and other deep work of a like character.

Provision can be made for disconnecting the toggle mechanism from the blank holders and connecting the outer and inner slides together, thus converting the presses into single-action machines. Spring-pressure attachments can be fitted to the beds of these presses, converting them into triple-action machines.

Several sizes are contained in the series, ranging in opening between the uprights from 84 to 120 in. and in weight from 85,000 to 240,000 lb.

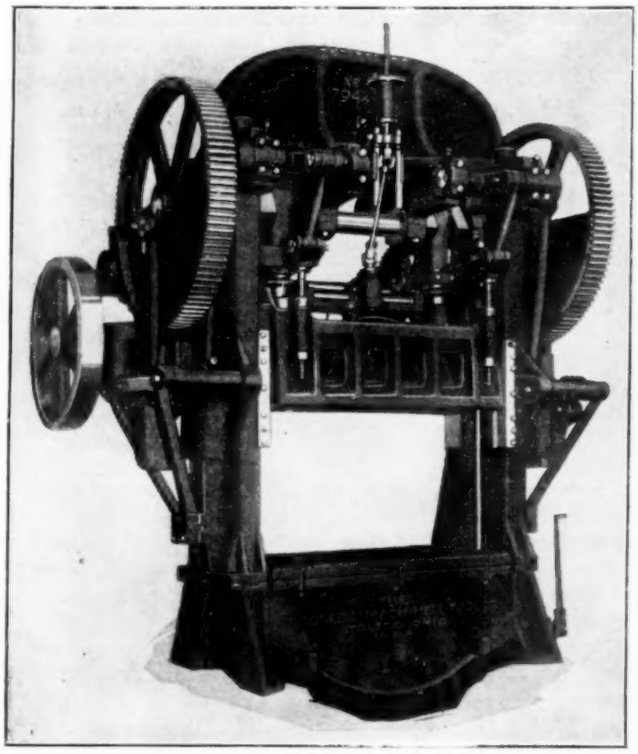
The specifications of the machine here illustrated are: Width between uprights, 84 in.; opening in bed, 28 x 76 in.; distance from bed to blank holder with stroke down and adjustment up, 52 in.; distance bed to plunger, with stroke down and adjustment up, 55 in.; adjustment of blank holder and plunger, 5 in.; stroke of blank holder, 11½ in.; stroke of plunger, 16 in.; weight of balance wheel, 1,800 lb.; speed, 250 r.p.m.; ratio of gearing, 27½ to 1; distance from floor to center of shaft, 153 in.; floor space, 110 x 195 in.; weight, 85,000 pounds.

Duff High-Speed Ball-Bearing Jack

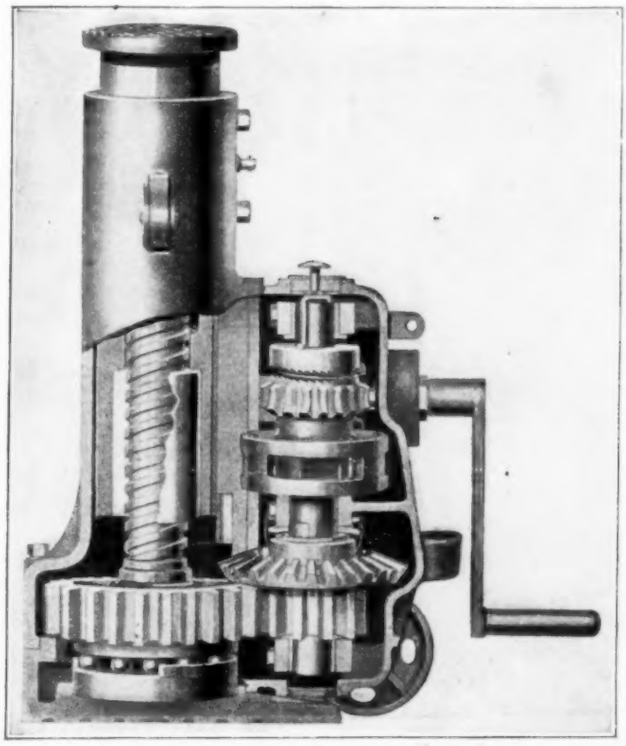
The Duff Manufacturing Co., Pittsburgh, Pa., has placed on the market a line of ball-bearing jacks, one size of which is shown in the illustration herewith. The operating mechanism of this jack is in the base so that the greater weight is at the bottom. By inserting the operating lever in a special socket, the jack can be tipped over on to the wheels with which it is provided and rolled to wherever needed.

The load is raised by means of a 6-ft. lever which operates a double-threaded screw through a ratchet and gearing. The screw has a steep pitch, turns in a bronze nut, and the thrust is taken by a ball bearing. For lowering the load, a crank handle is used.

It is claimed that safety in operation is assured by



TOLEDO DRAWING AND STAMPING PRESS

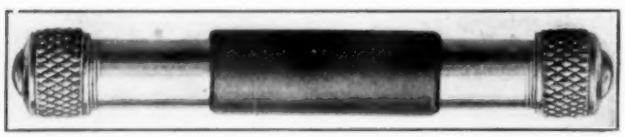


DUFF BALL-BEARING JACK

a positive clutch which holds the load at all times and that, regardless of the speed used in lowering, the load may be stopped at any desired point. The line comprises three sizes of jacks with heights of 20, 24 and 26 in. and capable of maximum raises of 6, 10 and 12 in. respectively. Each has a lifting capacity of 75 tons.

Jacques "Never Wear" Gages

The Production Equipment Co., 1 Madison Ave., New York, has placed on the market a line of end-measuring gages, one of which is shown in the illustration. The contact points are hardened-steel balls which are retained by screw caps as shown. As wear occurs the



JACQUES "NEVER WEAR" GAGE

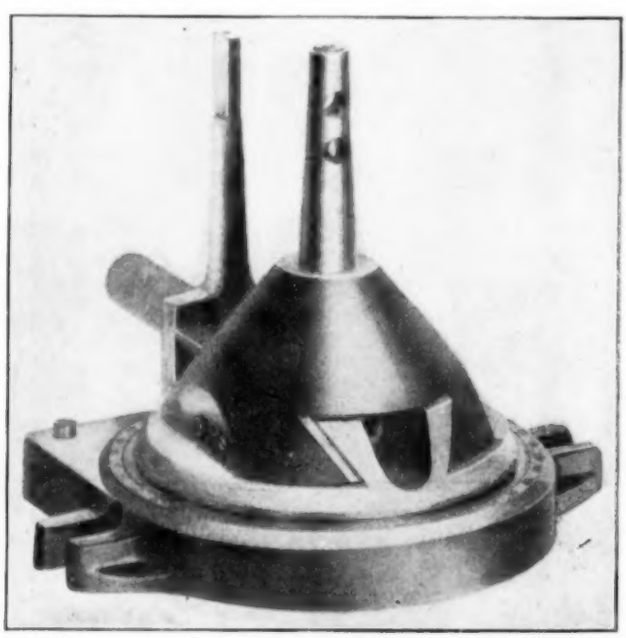
caps can be loosened and the balls turned to present new surfaces, thus compensating for wear.

Every gage is provided with rubber insulation to prevent expansion from the heat of the hand. The gages are made in sizes from 1 to 12 in., varying by inches, though any intermediate sizes can be furnished. It is claimed that the gages are accurate, though the degree of accuracy is not stated.

Miller Radius and Angle Grinding-Wheel Dresser

The S. L. & M. Sales Co., 408 Moffat Building, Detroit, Mich., has placed on the market a tool for dressing abrasive wheels with radius or angular faces as shown in the accompanying illustration.

It is claimed that this tool will dress a 12-in. wheel to a radius of from 0 to 1¼ in. either convex or concave, and also to any desired angle. The toolpost has a height adjustment of 2 inches.



MILLER RADIUS AND ANGLE GRINDING-WHEEL DRESSER

Corrected List of Boring Mills for Société le Construction Metallique

Here is the revised list of horizontal and vertical boring mills required for the War Department's contract with the Société le Construction Metallique of Belgium. We published the first list in our issue of Dec. 18, 1919, with the statement that revisions would be made in it as soon as we received them from the Director of Sales. The attention of manufacturers and dealers is called to this list and to the letter and editorial which appeared in our Dec. 18 issue.

Lists of bolt cutters, steam hammers, punches, shears, bending rolls, gap lathes, special lathes and grinding and milling machines will be published as the information is collected and released by the War Department.

VERTICAL BORING MILLS

Quantity	Size In.	Description	Customers' Identification Number
1	20	With one turret and one swivel head	801 V 8
3	24	With one turret head	509 F 43-44, 660 L 9
8	30	With one turret head	509 F 41-42, 217 B 10 281 B 6, 370 C 23-24 370-C 25-26
1	30	Regular	848 V 5
1	30	Regular (S. P. D.)	304 C 23
2	30	With plain boring bar	366 C 3-4
2	30	Regular, arranged for motor drive, but without motor	715 M 18-19
1	36	Regular	215 B 7
12	36	With one turret head	681 L 38-39, 406 D 5 502 F 25, 501 F 5 715 M 13-14-15-16-17 840 V 4-5
1	36	With one turret head—cone drive	207 B 7
1	36	With one turret and one side head	320 C 5
1	36	Bullard "New Era" with one side head, arranged for motor drive but without motor	659 L 8
2	38	With one plain and one turret head	366 C 7-8
7	42	With two swivel heads	509 F 36-37-38 366 C 6, 217 B 11 616 L 2
2	42	With one turret and one swivel head	509 F 95, 801 V 7
1	42	With one turret and one swivel head S.P.D.	659 L 1
1	42	Niles car-wheel boring machine	715 M 5
1	48	With two swivel heads	406 D 4
2	48	With two swivel heads arranged for motor drive, but without motor	715 M 20-21
1	60	With two swivel heads	509 F 39
1	84	With two swivel heads	320 C 6
2		Niles or Universal vertical boring mills with 4-ft. table	208 B 83-84
1		"Hole Hog" cylinder boring machine with four spindles for boring 4-in. hole	208 B 82

HORIZONTAL BORING, MILLING AND DRILLING MACHINES

Quantity	Size In.	Description	Customers' No.
12		No. 31 Lucas	223 B 27, 211 B 28-29 502 F 31, 509 F 126-127 801 V 3, 403 D 4 208 B 113-114-115, 617 L 7
1		No. 31 Lucas, arranged for motor drive but without motor	715 M 50
2		No. 31 Lucas, with 7-ft. bed and 34 x 48-in. platen	659 L 9, 219 B 11
3		No. 32 Lucas	684 L 9, 221 B 20, 429 D 12
1		No. 32 Lucas, with all accessories	717 M 2
1		No. 32 Lucas, with plain circular swiveling table	851 V 4
1		No. 2 Beaman & Smith (Catalog E-1900). Cone drive, one boring head and two facing heads	639 L 1
1		No. 1 Cleveland with 2½-in. spindle	617 L 6
1		No. 3 Detrick & Harvey with 20-ft. runway transportable table (1918 catalog)	304 C 88
1		No. 3 Detrick & Harvey with 10-ft. runway and 66-in. feed	319 C 22
1		No. 35 Landis (1917 catalog)	319 C 23
1		No. 3 Detrick & Harvey 10- to 12-ft. runway (outer support without base plate—(1918 catalog)	616 L 5
1		No. 3-A Universal	707 M 3
2		No. 2 Detrick & Harvey (1918 catalog), arranged for motor drive but without motor	715 M 49, 654 L 4

American Belting Needed

Although there are few factories in the Ciudad Juarez district of Mexico, says commerce reports, there is considerable demand for rubber, leather and canvas belting, and purchasing agents of local shops and mills would welcome quotations from American manufacturers. Quotations and descriptive literature may be in Spanish or English. As a rule, sales made to establishments in the district are consigned to their brokers at El Paso for passage across the border into Mexico.

Gages and the Ordnance Department

By E. C. PECK
General Superintendent, Cleveland Twist Drill Co.

The Army had to learn many things by bitter experience. Probably one of the hardest things to swallow was the lack of efficiency in the very field where we felt we led the world—quantity production. Colonel Peck tells something of the gage troubles of the Ordnance Department and gives the results of its experience.

THE object of this article is to place before the readers of the *American Machinist* a brief description of the gage troubles encountered in the manufacture of ordnance material during the World War.

It is believed and confidently hoped that the experience in interchangeable manufacture gained by the manufacturers and the Ordnance Department will result in future economy. It is predicted that manufacturing in the future, by the use of gages, will be carried on much more extensively than in the past.

A certain well-known and highly specialized shop was building two hundred machines per day with three hundred men. This shop was also making in large quantities one of the accurate fuses for the Government, and it was necessary to double the output on these fuses. Man power was unobtainable, so a large part of the force from the special machine department was transferred to the fuses. The superintendent then decided to fully gage the special machine job just as the munition job was. When this was finished and under way, two hundred machines per day were being turned out with one hundred and fifty men, and the product was strictly interchangeable with no fitting required. The cost of the change and gages was probably wiped out in three months. This is only one of many examples with which the writer constantly came in contact.

Importance of the Gaging System

The necessary transfer of the required skill to produce first-class uniform work in quantity is very materially aided by the application of a correct and suitable gaging system. This means that a correct and suitable system of gaging enables a manufacturer to obtain and spread over his organization the special ability of one good man, because correct gaging takes into consideration each step in production and hence each machining operation forms a part of the gaging analysis, and each receives its share of the ability of the good man.

It is a perfectly safe statement that a competent gage man who understands quantity production will save several times his salary every year, and produce a more uniform product.

Through the press and investigations by Congress, the War Department has been severely criticized, but the gigantic tasks imposed on some of the officers have received small consideration. It is well known to those on the inside that all of the failures were not army men—some of the loudest kickers against the regular army failed to make good on the jobs given them.

Roughly, the War Department expanded about one hundred to one. To get an idea of what this meant to the Engineering Division, let any manufacturer of special product increase his engineering and drafting force suddenly to one hundred times its normal force, and he will get a fair idea of the difficulties to be encountered. Let him consider further, that, besides building his regular product, he must take on a hundred foreign-made specialties which must be made interchangeable with the product already made in Europe. Consider also that the drawings are inaccurate and to an unfamiliar system, which requires the translation of voluminous documents forming a part of the drawings before they can be used. Consider still further that many of the dimensions, especially threads, had no tolerances given and in many cases the particular thread system was unknown and not recognizable from the samples submitted.

If a manufacturer can imagine these conditions and realize that many of the best men he can get for his greatly increased force never had experience in interchangeable manufacture, are unfamiliar with the product and never heard of manufacturing tolerances, he must realize the size of the problem he has to solve.

Picking the Personnel

One man alone, in helping to find the required engineers and draftsmen for this force, personally examined over five thousand applicants. It must be understood that he did not have the pick of the country to choose from, as many firms would not let their good men go. However, this country owes a lasting debt of gratitude to those manufacturers who were patriotic enough to sacrifice the services of their best men to help solve the problems.

It would be the realization of a tale of the Arabian Nights to expect such a force to come together without a percentage of incompetents; in fact, it was a wonderful opportunity for friends and relatives to fix up letters of reference which were bound to land some pet slacker in a bombproof job. Even this would not have been so bad, if these slackers had settled down to work and made good, but for the most part they would not learn the work they were to do, and many of them deliberately loafed and even boasted that civil service rules would not permit their dismissal. It should be said, however, that in the force collected, there were many excellent men who proved to be very capable and of the utmost assistance, and it is to this class that the credit is due for what was accomplished.

Early Errors Unavoidable

It is easily seen that at the outset there were bound to be ridiculous errors in judgment and design, but these were rapidly reduced as competent checkers were selected and developed who caught the mistakes before they got out.

One of the sources of trouble was the lack of standardized practice, and this is not to be wondered at when we consider that with all the standardizing which has been done very little of it actually applies to the making of drawings, so that there is a uniform interpretation of the exact requirements.

Eight sections of the Engineering Division designed ordnance material, and each section was responsible for the allowance between parts which fit together and the manufacturing tolerances to maintain proper functioning of these parts. An engineer's previous training

largely determined the refinement he called for in allowances and tolerances. If his experience had been in a first-class shop on high-grade work, his fits were close and tolerances small. If it had been on rough work, in a shop doing poor work, he would have liberal allowances and tolerances, or, as likely as not, no conception at all of tolerances, and in the latter case 0.0005 in. (one-half of one-thousandth) would look larger on paper than 0.005 in. (five thousandths), but very different in accomplishment.

The general lack of knowledge in the proper allowance to make a desired fit, even among otherwise competent engineers, was remarkable and the cause of much annoyance. It would almost approach the ridiculous, if the writer were to quote figures showing the difference in the opinions of some of the best engineers in the country, outside the Ordnance, when asked to set down the prescribed limits for a certain kind of fit made every day in almost any shop.

Setting Tolerances

This brings out one of the responsibilities of the engineer in this Ordnance work. He was expected to set down on paper a set of tolerances that would enable an untrained manufacturer to produce a million storage parts that would function properly without time to prove the dimensions. He could not be governed entirely by the manufacturers' opinions, as one would say the tolerance was too close and another would say he did not use all of the tolerance because the work was too "sloppy."

It is not hard to understand that, in the early days of the war, with a new, untried force at work on strange material, there would be improper allowances and tolerances prescribed. It is much harder for the writer to understand the attitude of some manufacturers who, instead of helping in time of war, sat back and criticized everything the Government did, at the same time refusing to help themselves, simply because they had an excuse to lay down. It was extremely fortunate for the Ordnance Department that this class was greatly in the minority, or there would have been nothing for our boys to fight with.

A noticeable feature in the relations between the Ordnance Department and some contractors was the harmony that prevailed, and their entire willingness to cooperate in every way. Very often ordnance matériel would function perfectly at the proving ground, and be condemned when it reached Europe where radical changes would be ordered. This required suspension of work and changes in the parts, which the contractor could not understand. Many of them turned in and helped; others "cussed" the War Department generally, and wrote their Congressman about it.

Effect of Gage Changes

The greatest single item which was closely related to all of the above trouble was that of gages. Every change in a dimension or tolerance affected the gages and many times called for entirely new ones, a procedure which was costly in both time and money.

The gage-making facilities before the war were so limited that, compared with the condition at the signing of the Armistice, they were practically unknown. Before the World War very few shops were making a strictly interchangeable product of first-class quality by the use of gages. Many thought and claimed they were, but investigation showed that the assembly was largely made by the selective process. Much of the work was done with "go" gages only, and the limits of acceptance were determined by a skilled workman judging the amount of shake between the piece and the gage. With a skilled workman trained to do this work a fair degree of interchangeability can be maintained in a single shop, as in the assembly parts can be fitted or selected to save scrapping those that were accepted by the poor judgment of the inspector. This method usually assures that the work will go together without interference, but there is no control on the quality of the fit, and the pieces may go together so loosely as to be useless for the purpose intended.

What Is Interchangeability?

Strict interchangeability consists in making, on a quantity-production basis, various component parts in different shops, so that they can be brought together and assembled properly according to the drawings. This means, first, that the standard unit of measure is comparable in each shop with some fixed standard; second, that all dimensions of the components are within the prescribed limits shown on a correct drawing. This is readily done by the use of "go" and "no-go" gages which represent the boundary lines fixed by the component dimensions.

The boundary lines should always be as far apart as the proper functioning will allow. In other words, the prescribed tolerances should be as great as the designer will risk for proper functioning. This is fundamental from a technical, as well as an economical standpoint. The allowances for proper fits, in quantity production, must prevent interference and allow the parts to go together after tolerances have been applied. This carries with it the assumption that a predetermined minimum allowance which must never be enroached upon admits of the proper assembly when the condition of extreme tight fits allowed by tolerance is present. If these allowances are too small there may be functioning trouble due to the parts working too tight, and if too great the fits may be so loose as to prevent proper working. The improper application of tolerance can produce either of the above conditions.

Cost of Too-Small Tolerances

If the tolerances are too small the work will be more costly as to labor, tools and gages. There will be more rejections and friction between inspectors and producers. This will bring about a condition in which the natural tendency will be to salvage the rejected parts. Salvaging by granting increased tolerances is generally bad practice, and it lowers the standard of work and discredits the designer's ability, especially if he has allowed all he is willing to risk. If tolerances are enlarged, the producer has a right to say, "If part of the product can be accepted with increased tolerances and will function properly, why not all of it?" It is therefore better to set them as large as can be risked in the beginning, and then live up to them. With this fundamental established the extreme component dimensions should be the master-gage dimensions, and any master-gage tolerance that is required must come out of the component tolerance in order that the extreme component boundary line is never exceeded, and in order to provide a means of making a number of master gages which shall be identical within a very small measurement. This really means that, if the master gages have any error, it is treated as an allowance for wear.

These master gages represent the exact physical measurements of the original component, and are for reference only. They are primarily for the checking of working, or inspection gages, and not supposed to be used on component parts. They may be duplicates of the component parts, or counter parts, or merely a check with one or two dimensions.

Inspection gages, as the name implies, are for accepting work in quantities which shall be within the dimensions shown on the component drawing, and as they are required from an economical standpoint to gage a large number of pieces during their life, they must be provided with an allowance for wear. The amount of this allowance is an economical question for each manufacturer to determine, keeping in mind that too small an amount increases gage cost, and too large an amount increases, to some extent, production cost. Where actual experience is lacking it is well to allow 10 per cent. of the component tolerance for the wear on inspection gages, and this amount is inside the component tolerances.

Working Gages

The working gages, as the name implies, are for the use of the workman producing the work, and may be duplicates of the inspection gages in design and size, but it is better practice to still further rob the component tolerance by making the working gages slightly nearer the mean of the component tolerance. This will insure that everything accepted by the working gages will pass the inspection gages. It requires less superintendence and helps to train good workmen.

Many manufacturers think that all of the tolerances allowed should be taken, and in attempting to do so have rejections by the inspectors. A No. 1 product is, of course, that which is the mean of the limits given, and one usually expects a large part of the product to be first class. Therefore, the mean dimension is the one a manufacturer should aim at; the successful ones do.

Most of the trouble during the recent war was caused by manufacturers trying to take all the tolerance and sacrifice the supervision necessary to produce work nearer the mean dimension. The result of working too near the boundary line was that large quantities of work exceeded the boundary line and were rejected. A great source of trouble was the failure of the manufacturers to grasp the idea that the boundary line established by the limits on the component drawing must not be exceeded. A typical example is illustrated by the following: The dimension on a component was 1.000 in. + 0.005 or — 0.005, which means that all pieces with dimensions between 1.005 in. and 0.995 in. would be accepted. If gages were submitted to the Bureau of Standards for verification, which would accept work one-ten-thousandth larger or smaller than the above limits, they would be rejected, and rightly, because they already exceeded the limits. But these gages could vary more than this amount and be accepted, if the variation was so that work accepted by them would be within the prescribed limits. One of the favorite criticisms was, "I have a component tolerance of 0.010 in. and they throw out my gage, when it is only out one-ten-thousandth, which is absurd." The trouble was that it was out in the wrong direction. If the error in the gage had been in the opposite direction, or so as to have it within component tolerance, it would have been accepted for either working or inspection gage, even if it had been out a whole thousandth of an inch.

If additional argument is needed, this subject of applied tolerances might be compared to target shooting. The outside of the target is the boundary line and is identical with the boundary line of the component dimensions. Any shot within the outside ring scores, but the marksman tries to hit the bull's-eye, and the oftener he does the better is his score. So it is with the manufacturer. Any of his pieces within the boundary will be accepted, but his final score, or worth as a desirable manufacturer, is based on how many times he hits the bull's-eye; that is, how much of his product is near the center or mean of the tolerances.

Any manufacturer who habitually produces work so near the rejection line that the inspector is in doubt as to whether or not he ought to reject it, certainly ought not to receive the same consideration as one who always produces work of a good uniform quality. This applies also to workmen and the majority of manufacturers are already familiar with this, but do not realize that it applies to the whole product as well.

The material out of which gages are made needs a thorough investigation, and this was started by the Gage Section, Engineering Division, of the Ordnance Department, but the signing of the Armistice practically stopped this section's activities in this direction.

The general practice was to make gages out of machinery steel pack-hardened; that is, a deep case-hardening process. This was especially true of thread gages, and as these were usually lapped to size before the present war, this means of finishing probably largely accounted for the choice of machinery steel pack-hardened, because it did not change as much in hardening as tool steel, and hence required less lapping. This method did not, however, produce gages of the required uniform accuracy, and grinding with abrasive wheels came rapidly into practice without, however, generally changing the material.

An investigation was made of the various conditions under which gages were used, their life, first cost and upkeep. This investigation included a summary of the records of the British Imperial Munitions Board and those of the United States Ordnance Department. A steel was selected for experiment and thread gages made for artillery ammunition and sent into the field for use with the usual instructions. At the signing of the Armistice and stopping of the work, the performance of the gages was collected and the records show an average life of eight times that of the combined average of the records above mentioned. Some of the gages had done ten times the average, and were still going with 25 per cent of their wear limit left for use. It was found that on a five-million contract for one thread only of a 75-mm. shell, gages of a similar quality would have saved $30,000 in the cost of the gages required on this contract.

Immigration and Emigration

Statistics for the twelve months ended June 30 have recently been made public, regarding immigration and emigration. In June, 17,987 immigrants arrived, or 3,740 in excess of the corresponding month in 1918. For the fiscal year 141,132 arrived, or about one-fourth more than in 1917-18, when low mark was reached with a total of 110,618.

Arrivals from Australia and Africa were few, while South America sent 3,271 and Asia 12,674. The greatest number of immigrants came from Canada, Mexico and Japan.

Sparks from the World's

By E. C. Porter,

Bonus Distributed by Fellows Gear Shaper Company

Following a custom inaugurated in 1916, the Fellows Gear Shaper Co., on Dec. 24, distributed an annual cash bonus to its employees. Approximately 665 employees received this bonus, which amounted to a total of $25,000, $20,000 of this amount being paid in gold.

The rating of this bonus is governed by the length of continuous employment, and is based on the total wages earned during the year. For the first and second years it is two per cent of the total wages earned, and increases by one per cent each succeeding calendar year up to ten per cent.

The bonus distribution this year was of special interest to those who were in the "Service" during the World War. To all of those who returned to the employ of this company, the bonus was calculated from the time of their original employment. That is to say, when they returned, they were not considered as new employees, and the time spent in the service of "Uncle Sam" was not deducted.

Of the 665 employees, approximately fifteen per cent received over five per cent bonus, which means that they had been in the employ of this company for over five years.

Three Associations to Hold a Triple Convention in Atlantic City

The National Supply and Machinery Dealers' Association, the Eastern Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers' Association will hold a triple convention in Atlantic City, N. J., May 17, 18, and 19, 1920. The headquarters for all three associations will be at the Marlborough-Blenheim. F. D. Mitchell is the secretary and treasurer of the American Supply and Machinery Manufacturers' Association, with an office at 4106 Woolworth Building, New York City.

Copper Production for the Past Year

The production of copper in the United States in 1919 was markedly smaller than in 1918, according to preliminary figures and estimates collected by B. S. Butler of the United States Geological Survey from all plants that make blister copper from domestic ores or that produce refined copper. At an average price of about 19c. a pound the output for 1919 had a value of $243,000,000, as against $471,000,000 for 1918.

The figures showing the smelter production from domestic ores represent the actual output of most of the companies for the first eleven months of the year and the estimated output for December. A few companies gave no figures for November but furnished estimates of the combined output of November and December. The production of blister and Lake copper from domestic ores was 1,278,000,000 lb. in 1919, against 1,908,000,000 lb. in 1918 and 1,224,000,000 lb. in 1913.

The supply of refined copper (electrolytic, Lake, casting and pig) from primary sources, domestic and foreign, for 1919 is estimated at 1,800,000,000 lb., compared with 2,432,000,000 lb. for 1918 and 1,615,000,000 lb. for 1913.

Ships Delivered Passes Mark Set by E. N. Hurley

Ship deliveries during the year 1919 totaled 6,229,323 deadweight tons, thus passing the 6,000,000 mark which was the annual figure set by former chairman E. N. Hurley as the goal to be worked toward.

This total included 741 steel ships, twelve composite, 403 wood and three concrete, a total of 1,159. The tonnage of the steel ships was 4,838,673, that of the composite ships, 42,000, that of the wood ships, 1,338,650, and that of the concrete, 10,000.

Up to date since the commencement of construction keels have been laid for 2,261 ships of a deadweight tonnage of 13,055,161. Those launched total 1,975, with a tonnage of 10,892,440, while those delivered total 1,740, with a tonnage of 9,557,444.

Foreign Commerce Corporation Formed by J. P. Morgan Company

J. P. Morgan & Co. announced on Jan. 1 the formation of the Foreign Commerce Corporation of America to engage in international trade. The incorporators are J. P. Morgan, H. P. Davison, T. W. Lamont, E. T. Stettinius, and Grayson M. P. Murphy who will resign from the Guaranty Trust Co. to accept the presidency of the corporation. The principal concern of the corporation will be to effect an improvement in the demoralized foreign exchange; it also promises to become a vehicle for the development of American trade in all parts of the world.

The Curtis Airplane and Motor Corporation Sold

The motor factories of the Curtis Airplane and Motor Corporation at Hammondsport, N. Y., were sold recently to L. J. Seely of that place. The plant has now been turned over to a new organization known as Keuka Industries, Inc., of which the officers are: L. J. Seely, president; John H. McNamara, vice president; K. B. MacDonald, secretary and treasurer. The directors are Glenn H. Curtis, Hammondsport; K. B. MacDonald, Buffalo; J. H. McNamara, Hammondsport; Hugh Satterlee, New York; L. J. Seely, Hammondsport.

Labor Disputes Decreasing, Says Federal Conciliation Director

The United States entered the new year with fewer pending industrial disputes than at any other time during the last three years, said Hugh L. Kerwin, Director of Conciliation of the Department of Labor, after receiving reports from the department's conciliators in the thirty-five great industrial centers of the country.

With the exception of the steel strike, the actual strikes throughout the country are few in number and of minor importance, Mr. Kerwin declared. There now are, he said, 101 industrial disputes before the department for adjustment, only twenty-one of which have reached the strike stage.

The industrial outlook for the year is excellent, Kerwin said, as all indications point to a cessation of the industrial unrest under which the country has suffered since the end of the war. The general tendency, he said, is for the employer and the worker to attempt adjustment of their differences without stopping work.

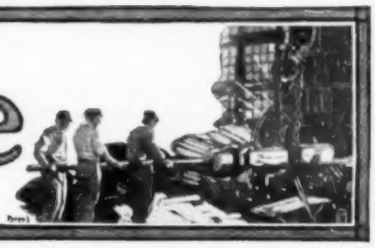
Will Investigate South American Markets

An investigation of the South American markets for industrial supplies will be conducted by P. S. Smith, trade commissioner of the Bureau of Foreign and Domestic Commerce, who will sail for Buenos Aires the latter part of January.

Mr. Smith will confer with manufacturers of machinery accessories before leaving for South America. He has arranged to meet interested manufacturers in Boston, Jan. 8, 9, 10; in Philadelphia, Jan. 15 and 16; and in New York, from Jan. 19 to the date of sailing.

Industrial Forge

News Editor



German Engineering Industries Preparing To Distribute Trade Papers in Foreign Countries

The German engineering industries are preparing a scheme to distribute their technical and trade papers in foreign countries on a large scale. Under the leadership of the National Association of German Manufacturers (Reichsverb and Deutcher Industrieller) and the Society of German Engineers (Verein Deutscher Ingenieure), a combine or trust of the German industrial press is to be formed for concerted efforts in the above-mentioned direction. Besides, a large monthly paper devoted solely to the export of engineering manufacture will shortly be issued in four languages: namely, English, French, German and Spanish. German works are subscribing freely to this enterprise in the shape of large display advertisements. The paper will have a large free circulation abroad, which is paid by the German works, each taking up the fees for a number of copies for a period of five years. Krupp's alone is said to have contracted to pay for a mailing list of 3,000 during that period. This part of the scheme is under the management of the "Ala" (Allgemeine Anzeigen Gesellschaft m.b.H.), a concern closely connected with the Rhenish industrial magnates. The "Ala" contemplates establishing offices in all foreign capitals to act as distributing centers, advertising agencies and news gatherers.

Minimum Export Prices of German Machine Tools

FROM OUR GERMAN CORRESPONDENT

The German machine-tool export has lately taken such vast dimensions that it has received close attention from the Government, resulting in a strict regulation of prices. The idea is to prevent price cutting below a certain minimum and to urge the works and dealers to get the best possible prices for their goods.

English and American export prices are not known here very well, but information on that point is being vigorously collected, to serve as a schedule for maximum prices. Export licenses are necessary for each single shipment and are subject to a strict control of sale prices. The administration of this business is in the hands of the "Association of Germany Machine-Tool Builders." The minimum export prices have been keyed to the pre-war standard. Up to now the formula "eight times pre-war price" has been in force. The ratio was increased since Dec. 1, to ten times pre-war price and has further been increased to eleven times pre-war price on Jan. 1.

A small lathe which used to be sold at 500 marks before the war cannot be sold for export at less than 5,500 marks after Jan. 1. As four to five times pre-war price is sufficient for the manufacturer to sell for home consumption at a reasonable profit, there is a wide margin between home and export prices, which makes export sales an exceedingly profitable business. It is not surprising therefore that there is a great rush to the export field and it is difficult to get tools quoted for domestic use. Dealers found themselves in some difficulty to get delivery and in consequence have made themselves liable to pay the manufacturers 75 per cent of the surplus price realized by export.

The strong tendency of the market has not failed to have effects on delivery times, especially as the manufacturing facilities are rather limited and far below the normal, mainly on account of the insufficient coal supply. The well-known works are sold out up to a year and more ahead, but there are enough stragglers whose chances are coming in the same degree as the works ranking higher get saturated with orders. The time, however, is coming when even the last straggler will be seized by the extraordinary wave of demand now going over the whole industry and it seems a safe prophecy that in a not far future a reaction will set in, owing to the impossibility to get delivery within a reasonable time.

Gun Stock Blanks to Be Sold By War Department

Informal proposals are invited by the War Department for the purchase of 1,215,000 walnut gun stock blanks, or any part thereof. These blanks are located at various points in the United States, principally in the East, and are available for immediate delivery, f.o.b. point of shipment nearest the purchaser's plant.

The blanks come in two sizes, the model 1917 being 51½ in. long by 2½ in. thick, tapering rifle shape from 6 in. at the butt to 1¾ in. at the tip; weight, 11 lb. 2 oz. The model 1903 is 45½ in. long by 2⅜ in. in thickness, tapering rifle shape from 6½ in. at the butt to 2 in. at the tip; weight, 8 lb. 5 ounces.

Detailed information may be obtained from the Ordnance Salvage Board, Ordnance Building, Washington, D. C.

Business Conditions in England

BY OUR ENGLISH CORRESPONDENT

LONDON, Dec. 1, 1919.

The demand for manufactured goods of all kinds cannot be met despite high prices and exchange difficulties, and the interest of the money market in industrial concerns is shown by the large and successful appeals for capital that have been made of late. The tendency to consolidation on the electrical side of engineering continues, the latest firm to join the English Electrical Co., Ltd., or rather to be associated with the company, being the Siemens Works at Stafford. In the immediate past, by reason both of want of technical experience and of want of capital and other resources, the British electrical concerns have been heavily handicapped in world competition; that is, as regards machinery of the heavier order. The English Electrical Co., one of several combinations, now has a group of associated works at Bradford, Coventry, Preston, Scotstoun, Rugby and at Stafford. Vickers, Ltd., probably the largest commercial organization in Great Britain, recently acquired the patent rights of the well-known Swiss engineers, Brown, Boveri & Co., for Great Britain and the British colonies and, again, have undertaken to finance and co-operate generally with the Swiss concern in western Europe.

To further co-operative effort, the Agricultural and General Engineers, Ltd., has been formed by old established firms, including Aveling & Porter, Rochester; E. H. Bentall & Co., Heybridge; Blackstone & Co., Stamford; R. Garrett & Sons, Leiston; and J. & F. Howard, Bedford. The managements remain unchanged, and, as in the case of the somewhat similar machine-tool combination, the firms do not lose their identities, but specialize in their own particular lines according to agreements.

In the motor industry, too, about which as regards production there has of late been much cry but little wool, amalgamation of interests will be effected in a new company (capital £6,000,000) now being formed. It includes Harper Sons & Bean, Dudley, with interests in Hadfields, Ltd., Sheffield; Harvey Frost & Co., Ltd., London, W.; Swift, Ltd., Coventry; British Motor Trading Corporation, Ltd., London, S. W.; the Vulcan Engineering Co., Ltd., Southport, and the whole share capital of Rushmores, Ltd., London, S. W.; Mosses Radiator Co., Ltd., London, W. C.; Regent Carriage Co.,

Ltd., London, S. W.; Gallay Radiator Co., Ltd., London, N. W.; and Jigs, Ltd., London, W. It is to be known as Harper Bean, Ltd. The first object at any rate is to produce motor cars at lower prices than prevail at present. It will also produce castings, stampings, etc., for other branches of the hardware trades.

It is not thought that full production will be reached in less than two years. The program starts with fifty cars a week at the beginning of 1920, rising to 600 by the end of the year and then to 2,000 a week. Apparently, too, the commercial vehicle is to receive attention, for the yearly output aimed at includes 50,000 small cars, 25,000 medium cars and 25,000 commercial vehicles.

In order to insure the interest of labor, some half a million ordinary fully paid £1 shares, to be held by trustees, will form a benevolent fund for work people and their dependents, the fund being controlled as regards disbursements by a committee formed by six of the directors and six of the employees.

Consolidation of interest is not confined to capital, for amalgamation of a number of the engineering trade unions has become almost certain. Such a proposal has been made many a time within the last thirty or forty years, usually only to be thwarted by the interests of the officials, some of whom necessarily would be displaced. A ballot has however recently been taken and eight trade unions voted in sufficient numbers to secure the proposed action, while seven societies failed. The figures so far given were 239,645 votes in favor of fusion and 42,665 against, 527,640 ballot papers being distributed. The statement has been made that the object is to gather together in one organization about half a million work people, with funds averaging about £7 per member. The leading union, the Amalgamated Society of Engineers, voted 56¾ per cent of full numbers, less than eight per cent of the votes being against the fusion.

In technical circles two matters have lately been discussed, one, limit systems; the other, standard spindle noses for milling machines. While the Herbert firm has put forward their standard system with hardened conical exterior and hardened box clutch (not dissimilar from the pattern understood to be recently adopted by the Brown & Sharpe Co.), on the other hand the British Machine Tool Makers, Ltd., the other organization endeavoring to spread the sale and use of British machine tools in other parts of the world than those under British government, has adopted what is really the standard of the Cincinnati Milling Machine Company.

On the question of limits there may be much more difficulty in reaching a satisfactory conclusion. The old engineering standards committee published a system on a shaft basis, and it is hardly an exaggeration to say that nobody in Great Britain worked to it. On the other hand, the British Engineering Standards Association, its successor, has for the better part of a year been considering the whole subject as regards plain cylindrical work, the system to be applicable to engineering generally. There seems to be no difficulty in accepting the hole as a basis, but whether the tolerance shall be uni-lateral or bi-lateral has been the subject of much discussion in the columns of the European edition of this journal. The former system would, of course, have the nominal size of hole as the minimum, all the tolerance being positive; several leading machine-tool firms support this. With the bi-lateral system, the nominal size would be of about the mean dimension, with tolerances on each side, positive and negative, and the Alfred Herbert firm, basing themselves on its own practice, advocates it. As a detail, it is supported with a view to adapting to the Coventry firm's standard holes parts—tool shanks being instanced—made abroad. To avoid mistakes and reduce numbers, in using gages, etc., only one set of tolerances for holes are employed, the firm working to limits for finest work only. Preliminary recommendations are expected shortly. The Standards Association has been making inquiries throughout the engineering industry, but a decision has not yet been reached. The association works generally for standardization at the instance of the particular branch of industry concerned, and all questions of detail are delegated to committees, the endeavor being to get these committees representative both of makers and of users, representatives of the latter often being in the larger proportion.

To turn to another direction, it has been obvious that the supply of electric generating plants during the war did not keep step with the demand, and more than one large town has experienced the effects of a breakdown in service. A quite unusual method of easing the load on the power station has been adopted by the committee responsible for the running of the Birmingham municipal electric supply. Connected to the supply mains with the possibility clearly before them, some of the factories have been warned that they must not take current between 3:30 and 5:30 in the afternoon, the object being to reduce the supply by 10,000 hp.-hr. Various ways out of the trouble have been suggested, and in certain instances overtime in the evening is being worked; but not always, for the British workman has set himself very definitely against anything of this character.

Perhaps the most absurd instance occurred not long since at the foundry of J. Lang & Sons, Ltd., Johnstone, the well-known lathe makers. Here a visit had been arranged for a section of the British Foundrymen's Association, a body of men interested in technical affairs. The visit was for a Saturday afternoon and the firm, thinking that everything should be in order, applied to the local branch of the prevailing ironfounders' union, for the use of the foremen and two or three men for demonstration purposes. But this was refused, the refusal being subsequently confirmed when the question was brought before the Glasgow headquarters of the trade union.

Signs of Foundry Strike Ending

The strike in the foundries continues but the signs that it will come to an end before long multiply steadily. Meanwhile, branches of industry dependent on castings close down or work at slower pace in increasing numbers, and even building extensions are stopped in some instances owing to the lack of guttering and so on. At Crewe, to take an example of engineering works, the locomotive fitting and erecting shops of the railway company have been placed on short time and other departments are working three or four days a week; the boiler shops, however, remain on full time. Thus, while about 300 molders are on strike at Crewe, their inaction has caused short time for about 6,000 men. British machine-tool shops of course feel the effects as well as other branches of engineering, and a leading English firm has been practically closed down as regards production for nine or ten weeks.

The exhibition to be held toward the end of next year at Olympia, London, W., under the control of the Machine Tool Traders' Association, shows every promise of success. As the result of a ballot a week or so ago almost the whole of the space has now been allotted to members. Any space available for outsiders will be notified shortly. The Athens exhibition organized by the federation of British industries, was so successful that it was extended a week beyond the original period. The exhibits, to the value of more than £500,000, have been practically all sold, while in many cases orders simply had to be refused for want of ability to undertake. The success of the Alfred Herbert exhibit of lathes, die heads, etc., at Philadelphia has been a matter of congratulation over here.

Trade Currents From Cleveland, Chicago and Philadelphia

Cleveland Letter

Difference in opinion as to what the immediate future holds out for the machinery industry of the Middle West is noted with the turn of the year among Cleveland and northern Ohio interests. While some manufacturers and distributors of standard equipment hold the view that the same high-class business will be seen as soon as the inventory-taking period is over, there are others who believe that a radical change must come in economic conditions before there will be a stabilized market.

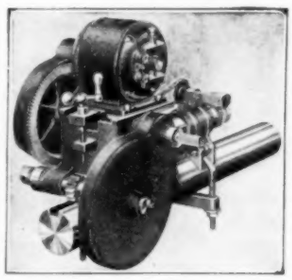
The claim is advanced that manufacturing costs have gone too high to com-

(*Continued on Page* 110*b*)

Condensed-Clipping Index of Equipment

Patented Aug. 20, 1918

Keyseating Machine, Portable
The Bucher-Smith Co., East Liverpool, Ohio,
"American Machinist," Sept. 25, 1919

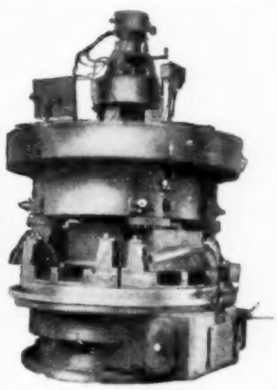


Size style A-2 has power feed; depth of cut is regulated by vertical screw. The main shaft is squared for hand-power operation. The motor is either alternating- or direct-current. The machine will cut keyways from ¼ to 1¼ in. wide by 12 in. long, and is suitable for shafts from 1¼ to 5 in. in diameter.

Vise, Toolmaker's
The Austin Tool and Machine Co., Inc., Pittsburgh, Penn.
"American Machinist," Sept. 25, 1919

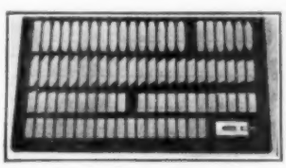
This vise is finished square on five sides, and fitted with a hardened and ground detachable jaw face, which is held by two screws. The movable swivel jaw is held down by a screw in the center, and has three V-grooves in the face for gripping round pieces either in the vertical or horizontal position. The jaws are 2 in. long and ⅝ in. deep and will hold round stock up to 1 in. in diameter.

Milling Machine, Continuous, Circular.
Ingersoll Milling Machine Co.,
Rockford, Ill.
"American Machinist,"
Oct. 2, 1919



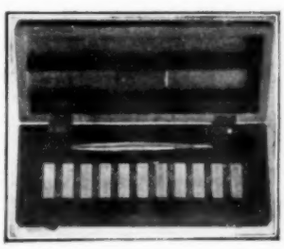
This machine has great production capacity on large pieces and needs small floor space. Cutter head carries from four to seven cutters and revolves in same direction as table, but at different speed. Continuous cutting, except at loading station. Two revolutions of table for roughing and finishing cut; each machine planned for single purpose. Approximate floor space required for 80-in. machine, 8 ft. 2 in. x 8 ft. 2 in. Approximate net weights, 60-in. machine, 35,000 lb., 80-in. machine, 45,000 lb.

Gages, Angle Block, Johansson.
C. E. Johansson, Inc., 245 West 55th St., New York, N. Y.
"American Machinist," Oct. 2, 1919



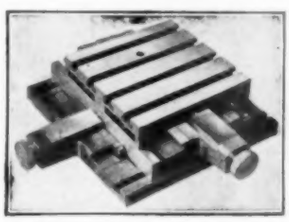
This set is about the same size as the standard set of size blocks but each block instead of having parallel edges has each of the four corners beveled off at a different angle. The angles have been so worked out that combinations from 1 min. of arc to 270 deg., varying by minutes, are possible. These blocks can be combined with the regular size blocks for making gages for angular formed cutters, checking sine bars, etc.

Gage Blocks, Johansson.
C. E. Johansson, Inc., 245 West 55th St., New York, N. Y.
"American Machinist," Oct. 2, 1919



This set of blocks is of more interest to the scientist than to the manufacturer or toolroom foreman. The set consists of 11 flat size blocks claimed to vary by equal amounts from 0.100000 in. to 0.100010 in.

Laying-out Fixture for Gaging
C. E. Johansson, Inc., 245 West 55th St., New York, N. Y.
"American Machinist," Oct. 2, 1919



This is a laying-out and locating fixture for use in combination with Johansson size blocks. The two movable beds are shifted by accurately cut screws ending in the large knurled nuts shown. The size blocks are inserted between carefully finished contact surfaces for each table. This fixture lends itself to a variety of uses in the shop and toolroom where quick and accurate work involving close measurements is to be done.

Caliper, Combination Micrometer
C. E. Johansson, Inc., 245 West 55th St., New York, N. Y.
"American Machinist," Oct. 2, 1919

This tool is flexible in each of the four sizes. The 200-mm. or 8-in. size has four standard blocks, 25, 50, 50 and 75 mm. in width, making it possible to get 25, 50, 75, 100, 125, 150, 175 and 200 mm. as zero settings for the micrometer screw or practically the range of eight micrometers. For measuring large diameters or deep holes, the jaws can be extended to full capacity; where rigidity of the caliper is important they may be drawn in until the screw of the measuring arm is close to the frame. The sizes are 100-, 200-, 300- and 400-mm.

Caliper, Registering Micrometer
C. E. Johansson, Inc., 245 West 55th St., New York, N. Y.
"American Machinist," Oct. 2, 1919

The friction retained pointer is released by the knob so that rapid readings can be taken while the work is revolving in the machine. If the light is poor the caliper may be carried to the light to be read, the setting being obtained without looking at the instrument. The caliper can be set at zero on a size block or on a master sample piece and the progress of the cutting determined by the distance on the scale from the pointer reading to the zero point.

Clip, paste on 3 x 5-in. cards and file as desired

pete with foreign production, and that the big export demand expected with the ending of the war not only does not exist, but is diminished by the fact that the American dollar is too high when competing with the currency of foreign countries. This view, when taken by firms catering largely to export trade, naturally seems well founded.

On the other hand, domestic business has kept up better through the last weeks of the year, according to leaders in the trade concentrating on business in the Cleveland and Ohio territories. They point to the fact that consumption is still somewhat ahead of production generally, and that the machinery industry feels this, in part at least. Certain kinds of equipment stand out in demand at the present. Punches and shears are particularly good. The sensational is totally lacking, it must be admitted, when large contracts are considered. The fill-in business is therefore much better than usual for the time of year.

About the most promising feature, in the opinion of some interests, is the fact that the railroads are promised to be returned to private ownership March 1. It is claimed by authorities in the machinery industry in this section that some of the biggest contracts in recent years are likely to be placed for manufacturing equipment, for all roads will require improvements in all directions. Big revival in machinery purchases is looked for in consequence.

Increase in Buying Looked For

Natural increase in buying is looked for by some firms as early as the middle of January, and in at least one instance inquiries and some orders have been coming in over the telephone, seemingly indicating that some manufacturing interests have foresworn the waiting attitude and are preparing to go ahead with their production.

The vote of 5,000 steel workers to continue striking in the Cleveland steel district was taken this week. The move, while of interest to industries depending upon steel production, means little, according to officials of the American Steel and Wire Co. The ranks of workers have been gradually filled so that there is not much in the way of work for those who would make application at this time, it is claimed.

In contrast to such discussions was the announcement of the Brown Hoisting Machinery Co. to give as Christmas presents turkeys to all employees. About a thousand employees were thus remembered. At 60 cents a pound, this made one of the biggest purchases of the month for purchasing agent R. G. Clapp. The turkeys were free and above the regular bonus this company awards to its employees each year.

The meaning of industrial research was discussed by R. E. Carpenter, manager of lynite laboratories of the Aluminum Castings Co., at the joint meeting of the American Society of Mechanical Engineers and the Cleveland Engineering Society at Hotel Statler.

E. A. Bartunek has been appointed welfare director and employment manager of the Vlchek Tool Co. He formerly was naturalization clerk for Cuyahoga County.

Chicago Letter

Continued good business marks the final week in the year and marked optimism is displayed on all sides in this district. While it is too early, yet, for figures on the entire year's business, it is assured that on the books of most dealers 1919 will show the greatest business, both gross and net, of any year in the history of the machine-tool industry, excepting only 1918. Had January and February been up to the mark set by the last ten months of the year, the record of 1918 would have been surpassed.

The volume of orders on book to be carried over into next year is enormous. Deliveries are even slower now than in the recent past, some heavy items requiring as much as six months. Inquiries and actual orders show no holiday laxness. Stocks are away down in quantity of tool on hand, but inventories will be relatively high owing to the increased value of the individual items.

Recent business continues to consist largely of scattered orders, but has been marked to a certain extent by the re-entry of the great corporations into the buying field. International Harvester has bought some tools and is considering others, and various railroads are making inquiries. The C. B. & I. has bought several items and more are now being ordered for its shops at Aurora. It is well known that the machine equipment of all the roads is in need of renewal so that the return of the roads to private ownership in March will undoubtedly mark the beginning of heavy purchases by these interests.

The year closes with prices about level with, or a little higher than, the peak reached in 1918. A readjustment upward is expected in the near future, based on constantly increasing costs, both of labor and raw materials. Such an advance will not affect the quantity of business, for the reason that all purchasers are being compelled to increase capacity, owing to the quantity of orders still on hand. Manufacturers are looking for increased efficiency, too, in an effort to beat rising costs, and this can only be attained by buying machinery of the most modern type.

Industrial building has fallen off materially in Chicago in December, the total being about half that of each of the preceding three months. This is occasioned by weather conditions, partly, and by recent increases in brick, sand and lumber. The Packard Auto Open Body Co. announces the start of a new million-dollar plant. The Stromberg Motor Devices Co. is starting a $300,000 plant, and the E. H. Wachs Co., manufacturing engines, is doubling the capacity of its plant at an ultimate cost of $100,000. It is probable that at the close of the holiday season many more announcements of industrial development will be made.

Philadelphia Letter

Many Philadelphia manufacturers are in the market for machine tools, but they are buying in small lots, and no large orders are reported from this part of the country. Comparatively few large new plants using machine tools are being erected. The railroads, which at this season are usually engaged in making up long lists of requirements, appear to be holding back until something definite is known as to the amount of assistance they are to receive from the Government.

Philadelphia differs from many of the Western cities. New manufacturing plants are springing up all through the Middle West and are sending out long lists of requirements. One large order is reported from Elizabeth, N. J., where a large purchase of machine tools has been made by the Willys corporation; but, in the main, business throughout the East appears to be pretty much the same as in Philadelphia.

Ordering in small lots is an indication that conditions for quick delivery are very bad. This branch of the industry is as bad if not worse than it was four months ago. Manufacturers of cheaper tools have benefited to a great extent from this inability on the part of older houses to fill orders promptly, inasmuch as there is usually a larger supply of the cheaper tools on hand, thus making it possible for the dealer in that class of material to make immediate delivery.

There has been a good demand lately for lathes and milling machines. Business in gear-cutting machines is usually brisk, owing to the comparatively few houses handling these tools, but at present it may be said to be even better than usual.

Foreign inquiries are for the most part referred back to the agency resident in the country from which the inquiry was received, and very few foreign orders have been filled here.

Commission Appointed to Appraise Arsenal Surplus Machinery

In order to reduce the machinery and equipment in Government arsenals and manufacturing plants, which had been working during the war under Government-aid contracts, to a peace-time basis, an appraisal commission has been appointed to determine what machinery and equipment in such plants and arsenals might be declared surplus.

The commission is composed as follows: Captain Lane Scofield, of the Ordnance Salvage Board; A. A. Fuller, chief of the machine-tool section, representing the Director of Sales; and J. F. Snyder, of the manufacturing section of the Ordnance Department.

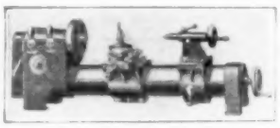
(Continued on Page 110d)

Condensed-Clipping Index of Equipment

Patented Aug. 20, 1918

Lathe, Urban, Bench

Ohio Tool and Machine Co., 2300 St. Clair St., Cleveland, Ohio.
"American Machinist," Oct. 2, 1919

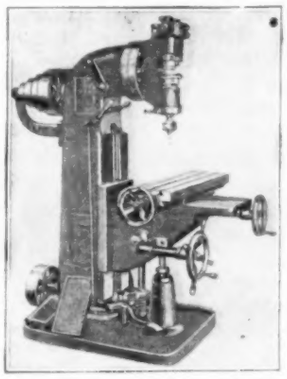


Five selected speeds and one reverse are furnished. The motor is built into headstock and direct-connected to the spindle with worm gearing inclosed and submerged in nonfluid oil. Lathe can be set up anywhere and power taken from a lamp socket. Attachable grinding wheel is furnished for grinding the tools. Lathe is built in three sizes, the one illustrated being the middle size.

Specifications: Swing over bed, 8 in.; swing over carriage, 6 in.; hole through spindle, $\frac{3}{4}$ in.; size of tools, $\frac{5}{8}$ x $\frac{5}{8}$ in.; ball-bearing spindle; tailstock spindle diameter, $1\frac{1}{16}$ in.; travel, $2\frac{1}{2}$ in.; centers, Morse taper No. 2.

Die Sinking Machine, Daly

Riverside Machinery Depot, Detroit, Mich.
"American Machinist," Oct. 2, 1919



Headstock is $15\frac{3}{4}$ in. in diameter and graduated. Main table moved by hand power only. Cherrying device incorporated into revolving head. Largest cone step, 14 in. in diameter; belt, 3 in.; hp., 5. Specifications: Height over all, 7 ft. 2 in.; base dimensions, 3 ft. 9 in. x 2 ft. 10 in.; vertical travel of knee, 22 in.; cross movement of table, 16 in.; longitudinal movement of table, 32 in.; size of table over all, $39\frac{1}{4}$ x 13 in.; net weight, 4700 lb.

Expanders, Boiler-Tube.

J. Faessler Manufacturing Co., Moberly, Mo.
"American Machinist," Oct. 2, 1919

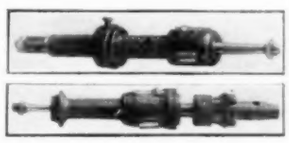
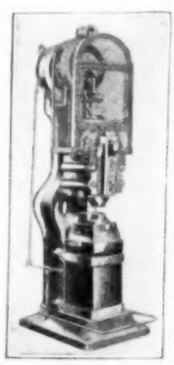


Fig. 1 shows an expander with the mandrel stop collar omitted, intended for use where tube must be expanded through a water space. The expander in Fig. 2 is to be used where there is no water space. The operation is identical in both cases. The expander is placed in tube with flaring roller just clearing tube end. Expander is self-feeding; the mandrel must be turned to right until tube is rolled tight in sheet. To flare tube, mandrel stop collar shown in Fig. 2 is placed against roller cage.

Guards, Safety, for Power Hammers

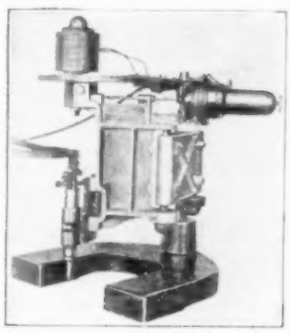
United Hammer Co., Oliver Bldg., Boston, Mass.
"American Machinist," Oct. 2, 1919



For all sizes of Fairbanks power hammers up to and including 500-lb. weight of ram, the 400- and 500-lb. sizes being recent additions to its line that were brought out for the heavier classes of work, such as found in locomotive shops, shipbuilding plants, etc. The guard, as shown, covers all working parts of the machine, the door permitting easy access. The guard can be easily attached to hammers now in operation as well as to new ones.

Cutting Machine, Camograph

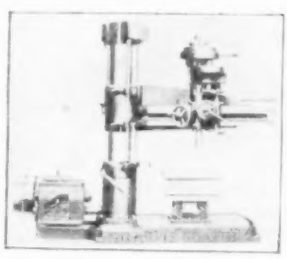
Davis-Bournonville Co., Jersey City, N. J.
"American Machinist," Oct. 2, 1919



Is automatic in action, used for cutting openings in steel plates. Oxy-acetylene torch moves over path determined by master cam. Feed roller is magnetised to hold it to cam face and also acts as traction driver, being driven by motor. Direct current, 110 volt, required. Specifications: width, 17 in.; depth, 15 in.; height, 25 in.; net weight, 125 lb.

Drilling Machine, Radial

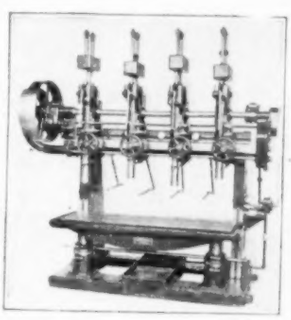
Silver Manufacturing Co., Salem, Ohio.
"American Machinist," Oct. 2, 1919



Manufacturered in three sizes to the following specifications: Sizes, $2\frac{1}{2}$ ft., 3 ft., $3\frac{1}{2}$ ft.; working surface of base, 31 x 33 in., 31 x 39 in., 31 x 45 in.; drills to center of 5 ft. 6 in., 6 ft. 6 in., 7 ft. 6 in.; traverse of head on arm, 23 in., 29 in., 35 in.; height of base, $6\frac{1}{2}$ in.; traverse of arm on column, 29 in.; maximum distance spindle to base, 50 in.; column diameter of outer sleeve, 9 in.; spindle traverse, 12 in.; Morse taper No. 4; maximum distance spindle to floor, 9 ft.; working surface of table, 16 x 22 in.; height of table, 19 in.; drive pulleys, 14 x $3\frac{1}{2}$ in.; net weights, 4250 lb., 4400 lb., 4560 lb.

Drilling Machine, Multiple-Spindle

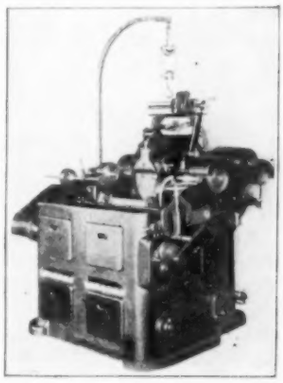
Edwin Harrington, Son & Co., Philadelphia, Penn.
"American Machinist," Oct. 2, 1919



Working surface of table, 5 ft. 1 in. x $18\frac{1}{2}$ in.; shortest distance between spindles, $5\frac{1}{2}$ in.; greatest distance between end spindles, 4 ft. 10 in.; vertical traverse of spindles, 10 in.; vertical movement of table, 13 in.; clear opening between uprights, 4 ft. 9 in.; Morse taper, No. 4; countershaft pulleys, T. & L., 20 in. x 5 in.; size of motor, 10 hp.; floor space, 8 ft. 4 in. x 4 ft. 1 in.; height over all, 7 ft. 11 in.; net weight, including countershaft, 6150 lb.

Grinding Machine, Plain

Woods Engineering Co., Alliance, Ohio
"American Machinist" Oct. 2, 1919



Maximum size of grinding wheel is 8-in. face by 20-in. diameter; centers take work 15 in. long by 10 in. in diameter. The machine occupies a floor space of 6 x 6 ft. and weighs 6000 lb. Crossfeed is accomplished by a rocking motion instead of the usual dovetail or V-slide arrangement. Headstocks and tailstocks are movably mounted on a square shaft having journals at the ends which operate in bronze-bushed, pedestal-type, dust- and grit-proof bearings.

Clip, paste on 3 x 5-in. cards and file as desired

The members of the commission will visit arsenals located at Watertown, Mass.; Watervliet, N. Y.; Rariton, N. J.; Frankfort, Pa., and Rock Island, Ill. In addition, they will visit approximately twenty manufacturing plants located in the East and the Middle West, which had been given Government aid during the war.

The amount of machinery and equipment that will be declared surplus by the commission and that will be offered for sale will depend upon the need of such material for the manufacturing program of the War Department. The commission will fix a price on all the equipment that is declared surplus for Army needs.

Personals

J. R. RICHARDS, formerly with the Fairbanks Co., New York City, has been transferred to its Philadelphia office.

DAN C. SWANDER, vice president of sales of the Standard Parts Co., Cleveland, Ohio, has been appointed general manager.

E. D. CLARAGE, for fourteen years manager of the Cleveland branch of the Columbia Tool Steel Co., has resigned, effective Jan. 1.

THEODORE C. GREENE, for a good many years employment manager of the Graton and Knight Manufacturing Co., Worcester, Mass., has resigned.

HUGO L. SIEGEL, formerly general sales manager for the Ford Roofing Products Co., is now with Walter A. Zelnicker Supply Co. as assistant to the president.

HUGO FRANKEL is now in charge of the tool and die departments of the Steckert Electric Machine Co., manufacturer of Eureka Vacuum Cleaners, Detroit, Mich.

D. J. RICE, who has for a number of years been identified with the small tool trade, has become associated with the Michigan Tool Co., Detroit, Mich., as sales manager.

ROY BRAKEMAN, formerly chief engineer of the Fairchild Works, American Steel and Wire Co., Fairfield, Ala., has been made chief engineer of the Otis Steel Co., Cleveland, Ohio.

WILLIAM C. SMITH, at one time the assistant manager of the Russell Motor Axle Co., Detroit, Mich., has been appointed president and general manager of the Detroit Hexagon Drill Co., Detroit, Mich.

ENLEN S. HARE, of Detroit, Mich., who recently became president of the Mercer Motors Co., Trenton, N. J., has also been made president of the Locomobile Co., Bridgeport, Conn. Both plants will be operated under the same directing heads. Mr. Hare will be in charge of the New York offices at 245 West 55th St.

W. E. LEWIS, who has been connected continuously with the United States Cast Iron Pipe and Foundry Company for the last 15 years, has been appointed resident manager of its plant at Anniston, Ala.

HARRY W. COBB, employment manager at the Heald Machine Co.'s plant, has resigned, and his position has been filled by Arthur E. Barr, who has been connected with the Heald concern for a number of years.

WM. H. CHAPPELL, formerly superintendent of the Page-Storms Drop Forge Co., Springfield, Mass., has become connected with the General Railway Signal Co., Rochester, N. Y., as superintendent of its forge department.

A. L. MERCER, assistant director of sales of the War Department, has resigned from that position to become president of the Needham Tire Co., Needham, Mass. Mr. Mercer, whose resignation became effective Jan. 1, will be succeeded by Major H. S. Johnson, who is now special assistant to the director of sales.

RUSSELL W. STOVEL, who recently returned from France, where, as lieutenant-colonel of Engineers, he served as chief of the terminal facilities division of the Army Transport Service, has been appointed a consulting engineer of Westinghouse, Church, Kerr and Co., Inc., and, as a member of that organization, will devote his entire time to the company's electrical and mechanical work.

Business Items

The Ross Manufacturing Co., of Cleveland, Ohio, has moved into its new plant at 3160 West 106th St.

The Tool and Auto Parts Co., East and St. Claire Ave., Cleveland, Ohio, is a new concern, recently incorporated for the purpose of manufacturing tools, and automobile parts.

The Massachusetts Blower Co., Boston, Mass., has re-opened its Boston office which is located in the Kimball Building, 18 Tremont St. This office is in charge of A. C. Barlett.

The corporate name of the Ladewig & Stock Co., Waukesha, Wis., has been changed to the Ladewig Co. The new company assumed all the assets and liabilities of the old company. There will be no change of officers and the policies of the company will remain the same as formerly.

L. Best & Co., has moved its business to 28-30 West Broadway, N. Y., where it has secured larger quarters. The increase in floor space is nearly a hundred per cent and will permit the company to display its products, such as grinding wheels, machinery and polishing supplies to a much greater advantage.

The Hendricks Manufacturing Co., and Rothweiler & Co., both of Seattle, Wash., have been consolidated under the name of H. R. L. Motor Co. The officers of the company are: J. J. Hendricks, president; H. N. Rothweiler, vice president; J. A. Lagoe, general manager, and H. G. Mead, purchasing agent. The company will manufacture three-quarter-ton, one-half-ton and two-ton motor trucks.

Obituary

CHARLES KEITH BLACKWOOD, vice president, assistant treasurer and a director of the Sullivan Machinery Co., Chicago, Ill., died on Dec. 14, 1919.

CHARLES E. SMITH, superintendent of the Smith-Egge Manufacturing Co., Bridgeport, Conn., and connected with this firm for more than forty years, died Dec. 16, 1919, at his home 732 Lafayette St. Mr. Smith was sixty-two years old.

THOMAS J. MCGONNELL died recently at his home, 110 Neville St., Pittsburgh, Pa. He was born and resided all of his life in Pittsburgh and was connected with the United Engineering and Foundry Company for more than twenty years.

WILLIAM H. HART, of New Britain, Conn., died Dec. 13, 1919, at his home on Lexington St. Mr. Hart was one of the founders of the Stanley Works, manufacturers of butts and hinges, etc., and had been with the company for over fifty years prior to his retirement from active affairs in January, 1918.

Forthcoming Meetings

Boston Branch, National Metal Trades Association. Monthly meeting on first Wednesday of each month, alternating with the Employers' Association of eastern Massachusetts. George D. Berry, secretary, room 50-51, 166 Devonshire St., Boston, Mass.

Engineers' Club of Philadelphia. Regular meeting the third Tuesday of the month. Lewis H. Kenney is the chairman of committee on papers.

Electric Hoist Manufacturers' Association. Monthly meeting at the offices of the Yale & Towne Manufacturing Co., 9 East 40th St., New York City. Secretary W. C. Briggs, Shepard Electric Crane and Hoist Co.

Engineers Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

The motor-truck sections of the 20th Annual Automobile Shows of 1920 will hold an exhibition in the 8th Coast Artillery Armory, New York, Jan. 3 to 10, 1920, and in the International Amphitheatre, Chicago, Ill., Jan. 24 to 31, 1920.

Philadelphia Foundrymen's Association. Meeting first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn., Howard Evans, secretary, Pier 45, North Philadelphia, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting last Thursday. O. L. Angevine, Jr., secretary, 547 Arnett Boulevard, Rochester, N. Y.

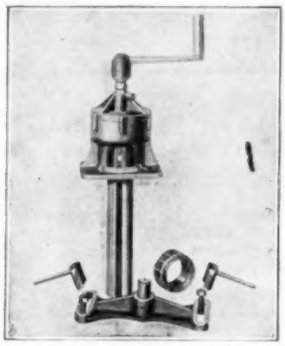
The Society of Automotive Engineers will hold its annual meeting in New York on Jan. 6 to 8, inclusive. For further information of program, address the meeting committee, 239 West 39th St.

Condensed-Clipping Index of Equipment

Patented Aug. 20, 1918

Boring and Burnishing Tool, Cylinder
Michigan Machine Co., Detroit, Mich.
"American Machinist," Oct. 2, 1919

Its function is to rebore and burnish cylinders for Fordson tractors and Ford model T engines only. It can be operated either by hand or power, as a crank is furnished for hand operation and a universal joint suitable for any drilling machine can be used where power is available.



Setting Machinery, Pilocollan Method
Dr. George Wettstein, Swiss Consulate, New York.
"American Machinist," Oct. 2, 1919

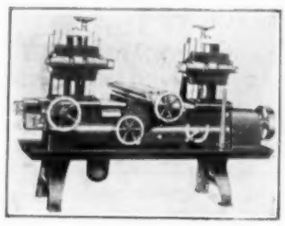
The Pilocollan method of fastening machines to the floor consists of interposing between the floor and the foot of the machine a specially prepared felt pad of a variable thickness according to the size and weight of the machine. Both sides of the pad are coated with a preparation that is heated for use and on cooling becomes adhesive.

Planing Machine
Cincinnati Planer Co., Cincinnati, Ohio.
"American Machinist," Oct. 16, 1919

Design includes forced feed lubrication, quick power traverse, interlocked against accidental operation, herringbone gears for drive, box bed and table construction and two-speed drive. Above design furnished in all sizes from 30 in. to 72 in.

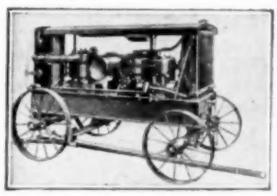
Milling Machine, Duplex
W. B. Knight Mchy. Co., 3920 West Pine St., St. Louis, Mo.
"American Machinist," Oct. 16, 1919

Recommended by the makers for rapid milling on a production basis; spindles capable of independent operation. Specifications: Maximum distance between spindles, 26 in.; vertical adjustment, 10 in.; diameter of tapered spindles, 2⅜ to 1⅞ in.; length of bearings, 9¼ in.; spindle speeds, eight; range, 30 to 300; taper holes, B. & S. taper No. 10; working surface of table, 37 x 10 in.; longitudinal feed, 24 in.; number of feeds, six; range (per revolution of spindle), 0.008 in. to 0.060 in.; floor space, 103 x 84 in.; net weight, about 3450 lb.



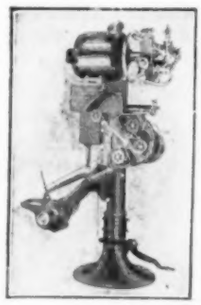
Compressor, Portable Air
Ingersoll Rand Co., 11 Broadway, New York, N. Y.
"American Machinist," Oct. 16, 1919

Built in two sizes; known as "Imperial Type 14"; all-steel outfits with four-cylinder tractor-type gasoline engine; large machine has capacity of 210 cu.ft. and weighs 6000 lb.; small machine, 118 cu.ft. and weighs 4000 lb.; engines have automatic governors, magneto ignition and are water-cooled; machine can be completely inclosed.



Winding Machine, Armature
P. E. Chapman Electric Wks., St. Louis, Mo.
"American Machinist," Oct. 16, 1919

Style 3, adjustable to any style and size of random wound bipolar drum armature; any wire from No. 20 to No. 36. Machine has special lead-forming features; is self-contained, includes motor, controller, turn counter, etc. Reel holder is automatic and controlled by dynamometer. Tension device permits quick starting, high speed, good tension and quick stops.

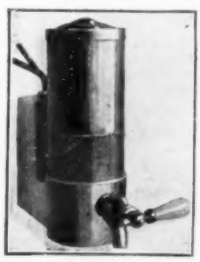


Transformers, Steel Clad
Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn.
"American Machinist," Oct. 16, 1919

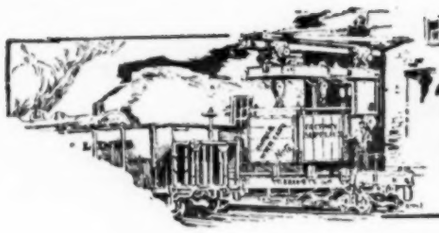
Same as type S, except change in tank construction, combining light weight and strength. Built of sheet steel; color grey; can be mounted direct on poles without platforms.

Heater, Automatic Water
Bridgeport Machine and Tool Manufacturing Co., Bridgeport, Conn.
"American Machinist," Oct. 16, 1919

This device will furnish either hot or cold water, according to the direction the handle is turned; advantageous where there is a single faucet, and saving a pipe line in the case of a new installation. Being automatic, takes current only when supplying hot water; capacity, 90 gal. per hour, with a current consumption of 6.6 kw. per hour. Adapted for voltages of 110 or 220.



Clip, paste on 3 x 5-in. cards and file as desired



THE WEEKLY PRICE GUIDE

IRON AND STEEL

PIG IRON—Quotations compiled by The Matthew Addy Co., as per Department of Commerce Committee Schedule.

	Current	One Month Ago
CINCINNATI		
No. 2 Southern	$36.60	$36.60
Northern Basic	34.00	34.00
Southern Ohio No. 2	36.55	36.55
NEW YORK—TIDEWATER DELIVERY		
2X Virginia (Silicon 2.25 to 2.75)	39.40	39.40
Southern No. 2 (Silicon 2.25 to 2.75)	41.40	41.40
BIRMINGHAM		
No. 2 Foundry	33.00	33.00
PHILADELPHIA		
Eastern Pennsylvania No. 2	38.10*	38.10
Virginia No. 2	39.10*	39.10
Basic	34.60†	34.60
Grey Forge	34.60*	34.60
CHICAGO		
No. 2 Foundry local	36.25	36.25
No. 2 Foundry, Southern	38.00	38.00
PITTSBURGH, INCLUDING FREIGHT CHARGE FROM VALLEY		
No. 2 Foundry		
Basic	34.40	34.40
Bessemer	35.40	35.40

* F. o. b. furnace. † Delivered.

STEEL SHAPES—The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses at the cities named:

	New York Current	New York One Month Ago	New York One Year Ago	Cleveland Current	Cleveland One Year Ago	Chicago Current	Chicago One Year Ago
Structural shapes	$3.47	$3.47	$4.27	$3.62	$4.17	$3.47	$4.27
Soft steel bars	3.52	3.52	4.17	3.52	4.17	3.52	4.17
Soft steel bar shapes	3.52	3.52	4.17	5.50	4.17	3.52	4.17
Soft steel bands	4.22	4.22	4.77				
Plates, ¼ to 1 in. thick	3.67	3.67	4.52	3.82	4.42	3.67	4.25

Note—For less than carload lots, add 4½c. per 100 lb.

BAR IRON—Prices per 100 lb. at the places named are as follows:

	Current	One Year Ago
Mill, Pittsburgh	$3.50	$3.50
Warehouse, New York	3.52	4.75
Warehouse, Cleveland	3.42	4.67
Warehouse, Chicago	3.52	4.10

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the base quotations from mill:

	Mill Carloads, Pittsburgh	New York Current	New York One Year Ago	Cleveland	Chicago
No. 28 black	$4.35–4.85	$7.00–8.00	$6.52	$5.77	$6.00
No. 26 black	4.25–4.75	6.90–7.90	6.42	5.67	5.90
Nos. 22-24 black	4.20–4.71	6.85–7.85	6.37	5.62	5.85
Nos. 18-20 black	4.15–4.65	6.80–7.80	6.32	5.57	5.80
No. 16 blue annealed	3.75–4.20	6.02	5.72	5.17	5.02
No. 14 blue annealed	3.65–4.10	5.92	5.62	5.07	4.92
No. 10 blue annealed	3.55–4.00	5.50–6.00	5.52	4.97	4.82
No. 28 galvanized	5.70–6.20	7.50–9.00	7.77	7.12	7.25
No. 26 galvanized	5.40–5.90	7.20	7.47	6.82	6.95
No. 24 galvanized	5.25–5.75	7.05	7.32	6.57	6.52

COLD FINISHED STEEL—Warehouse prices are as follows:

	New York	Chicago	Cleveland
Round shafting or screw stock, per 100 lb. base	$5.00	$4.90	$5.00
Flats, square and hexagons, per 100 lb. base	5.50	5.40	

DRILL ROD—Discounts from list price are as follows at the places named:

	Per Cent.
New York	55
Cleveland	50
Chicago	50

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots is:

	Current	One Year Ago
New York	$21.00–26.00	$19.00
Cleveland	20.00	20.00
Chicago	16.50	19.00

In coils an advance of 50c. usually is charged.
Domestic iron (Swedish analysis) is selling at 15c. per lb.

WELDING MATERIAL (SWEDISH)—Prices are as follows in cents per pound f.o.b. New York, in 100 lb. lots and over:

Welding Wire		Cast-Iron Welding Rods	
1, 1½, 5/16, ¼, 7/32, 3/16	21.00 to 30.00	3/16 by 12 in. long	14.00
No. 8, 9/32 and No. 10		¼ by 19 in. long	12.00
5/16		5/16 by 19 in. long	10.00
No. 12		⅜ by 21 in. long	10.00
7/32, No. 14 and 1/16		Special Welding Wire, Coated	
No. 18		¼	33.00
No. 20		5/16	30.00
		⅜	38.00

Domestic 20c. for 1/16, 15c. for ¼ to 3/16

MISCELLANEOUS STEEL—The following quotations in cents per pound are from warehouse at the places named:

	New York Current	Cleveland Current	Chicago Current
Openhearth spring steel (heavy)	6.00	8.00	8.00
Spring steel (light)	8.00	10.00	10.00
Coppered bessemer rods	8.00	8.00	6.75
Hoop steel	4.47	4.75	4.07
Cold-rolled strip steel	8.40	8.25	7.50
Floor plates	5.67	6.00	5.92

Note—For less than carload lots, add 4½c. per 100 lb.

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh; basing card of National Tube Co. for steel pipe, Cardry A. M. Byer's Co. for iron, both dated Mar. 21, 1919.

BUTT WELD

Steel Inches	Steel Black	Steel Galvanized	Iron Inches	Iron Black	Iron Galvanized
⅛, ¼ and ⅜	50½%	24%	⅛ to 1¼	30%	23½%
½	54½%	40%			
¾ to 3	57½%	44%			

LAP WELD

2	50½%	35%	2	32½%	18½%
2½ to 6	53½%	41%	2½ to 6	34½%	21½%

BUTT WELD, EXTRA STRONG PLAIN ENDS

⅛, ¼ and ⅜	46½%	29%	⅛ to ⅜	39½%	24½%
½	51½%	39%			
¾ to 1¼	55½%	43%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	48½%	37%	2	33½%	20½%
2½ to 4	51½%	49%	2½ to 4		23½%
4½ to 6	50½%	39%	4½ to 6	34½%	22½%

Stock discounts in cities named are as follows:

	Black	Galv.	Black	Galv.	Black	Chicago Galv.
⅛ to 3 in. steel butt welded	47%	31%	43½%	34½%	57½%	44%
2½ to 6 in. steel lap welded	42%	27%	45½%	39½%	53½%	41%

Malleable fittings. Class B and C, banded, from New York stock sell at plus 12½% less 5%. Cast iron, standard sizes, 10–5% off.

METALS

MISCELLANEOUS METALS—Present and past New York quotations in cents per pound, in carload lots:

	Current	One Month Ago	One Year Ago
Copper, electrolytic	19.00	20.00	26.00
Tin in 5-ton lots	59.00	53.87½	72.00
Lead	7.87½	6.80	7.05
Spelter	9.25	8.30	8.60
ST. LOUIS			
Lead	7.50	6.55	6.75
Spelter	8.87½	7.95	8.25

* Lead scarce in New York market.

At the places named, the following prices in cents per pound prevail, for 1 ton or more:

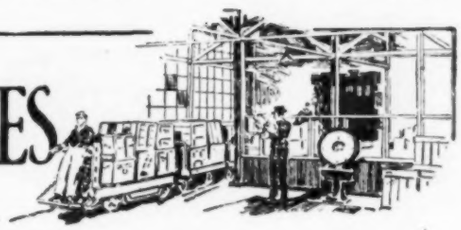
	New York Current	New York Month Ago	New York Year Ago	Cleveland Current	Cleveland Year Ago	Chicago Current	Chicago Year Ago
Copper sheets, base	28.50	33.50	38.00	29.50–31.00	38.00	35.00	38.00
Copper wire (carload lots)	28.00	29.00	35.00	28.50	35.00	26.00	38.00
Brass sheets	25.50	32.00	39.75	28.00	30.50	26.00	38.00
Brass pipe	30.50	36.00	46.00	34.00	42.50	34.00	44.00
Solder (half and half) (case lots)	35.00	45.00	55.00	35.50	47.50	33.00	65.00

Copper sheets quoted above hot rolled 16 oz., cold rolled 14 oz. and heavier, add 2c.; polished takes 5c. per sq.ft. extra for 20-in. widths and under; over 20 in., 7½c.

BRASS RODS—The following quotations are for large lots, mill, 100 lb. and over, warehouse; net extra:

	Current	One Year Ago
Mill	22.75	36.00
New York	24.00	38.40
Cleveland	28.00	38.50
Chicago	25.00	29.50

SHOP MATERIALS AND SUPPLIES



ZINC SHEETS—The following prices in cents per pound prevail:

Carload lots f.o.b. mill 11.50

	In Casks		Broken Lots	
	Current	One Year Ago	Current	One Year Ago
Cleveland	11.50	18.75	12.00	21.50
New York	13.00	17.00	13.50	20.25
Chicago	15.00	22.00	15.00	21.50

ANTIMONY—Chinese and Japanese brands in cents per pound, in ton lots for spot delivery, duty paid:

	Current	One Year Ago
New York	9.50-9.75	9.50-10.50
Chicago	10.50	10.00
Cleveland	11.75	11.625

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York		Cleveland		
	Current	One Year Ago	Current	One Year Ago	Chicago
Copper, heavy and crucible	18.00	18.00	18.50	21.00	17.25
Copper, heavy and wire	17.50	17.00	19.00	21.00	16.75
Copper, light and bottoms	15.75	15.00	15.50	19.00	15.75
Lead, heavy	7.00	5.00	6.25	6.00	6.50
Lead, tea	5.00	4.00	4.25	5.00	5.50
Brass, heavy	9.00	9.50	13.25	14.50	17.00
Brass, light	8.00	8.50	9.75	11.50	10.00
No. 1 yellow brass turnings	9.50	10.00	11.50	13.50	10.50
Zinc	6.75	5.00	5.00	5.50	6.00

ALUMINUM—The following prices are from warehouse at places named:

	New York	Cleveland	Chicago
No. 1 aluminum, 98 to 99% pure, in ingots for remelting (1-15 ton lots), per lb	33.00c.	34.00c.@35.00c.	33½c.

COPPER BARS—From warehouse sell as follows in cents per pound, for ton lots and over:

	Current	One Year Ago
New York (round)	34.00	40.00
Chicago	28.00	40.00
Cleveland	31.00	33.50

BABBITT METAL—Warehouse price per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	90.00	95.00	68.50	93.00	60.00	96.00
Commercial	50.00	50.00	17.25	23.00	13.00	25.00

SHOP SUPPLIES

NUTS—From warehouse at the places named, on fair-sized orders, the following amount is deducted from list:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Hot pressed square, List	.80	$1.00	$1.25	$1.45	.98	
Hot pressed hexagon List	.80	1.00	1.05	1.45	.78	
Cold punched hexagon List	2.50	1.00	.75	1.05	1.00	
Cold punched square List	2.50	1.00	.75	1.05	1.00	

Semi-finished nuts sell at the following discounts from list price:

	Current	One Year Ago
New York	70-5%	50-10%
Chicago	50%	50%
Cleveland	60-10%	50-10%

MACHINE BOLTS—Warehouse discounts in the following cities:

	New York	Cleveland	Chicago
½ by 4 in. and smaller	30%	50%	35-5%
Larger and longer up to 1¼ in. by 30 in.	20%	40%	25-5%

WASHERS—From warehouses at the places named the following amount is deducted from list price:

For wrought-iron washers:

New York ..... $1.50 Cleveland ..... $3.75 Chicago $3.00

For cast-iron washers the base price per 100 lb. is as follows:

New York ..... $7.00 Cleveland ..... $3.75 Chicago $4.25

CARRIAGE BOLTS—From warehouses at the places named the following discounts from list are in effect:

	New York	Cleveland	Chicago
½ by 6 in. and smaller	25%	40-5%	30%
Larger and longer up to 1 in. by 30 in.	15%	37½%	20%

COPPER RIVETS AND BURS sell at the following rate from warehouse.:

	Rivets		Burs	
	Current	One Year Ago	Current	One Year Ago
Cleveland	30%	List plus 10%	30%	List plus 10%
Chicago	20%	List price	20%	List plus 20%
New York	30%	15% from list	10%	List plus 5%

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	40%	55% off	50%
Tinned	40%	55% off	50%

Boiler, ½, ¾, 1 in. diameter by 2 to 5 in. sell as follows per 100 lb.:

New York ..$5.00 Cleveland ...$4.00 Chicago ....$4.87 Pittsburgh ...$4.72

Structural, same sizes:

New York ...$5.10 Cleveland ...$4.10 Chicago ....$4.97 Pittsburgh $4.82

MISCELLANEOUS

SEAMLESS DRAWN TUBING—The base price in cents per pound from warehouse in 100-lb. lots is as follows:

	New York	Cleveland	Chicago
Copper	32.00	36.00	35.00
Brass	30.50	34.00	34.00

For immediate stock shipment 3c. is usually added. The prices, of course, vary with the quantity purchased. For lots of less than 100 lb., but not less than 75 lb., the advance is 2c.; for lots of less than 75 lb., but not less than 50 lb., advance is 5c. over base (100-lb. lots); less than 50 lb., but not less than 25 lb., 10c. should be added to base price; quantities from 10-25 lb., extra is 25c.; less than 10 lb., add 35c.

Double above extras will be charged for angles, channels and sheet metal mouldings if ordered in above quantities. Above extras also apply to brass rod other than standard stock sizes—stock sizes being considered as ⅛-2 in. inclusive in rounds, and ¼-1½ in., inclusive, in square and hexagon—all varying by thirty seconds up to 1 in. by sixteenths over 1 in. On shipments aggregating less than 100 lb., there is usually a boxing charge of $1.50.

COTTON WASTE—The following prices are in cents per pound:

	NEW YORK			
	Current	One Year Ago	Cleveland	Chicago
White	13.00	11.00-13.00	14.00	11.00 to 14.00
Colored mixed	9.00 to 12.00	8.50-12.00	11.00	9.50 to 12.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½x13½	13½x20½
Cleveland	52.00	58.00
Chicago	41.00	43.90

SAL SODA sells as follows per 100 lb.:

	Current	One Month Ago	One Year Ago
New York	$2.25	$2.25	$1.75
Philadelphia	2.00	2.00	1.75
Cleveland	2.50	2.50	2.625
Chicago	2.00	2.00	2.00

ROLL SULPHUR in 360-lb. bbl. sells as follows per 100 lb.:

	Current	One Month Ago	One Year Ago
New York	$3.40	$3.40	$3.65
Cleveland	4.625	3.875	4.25
Chicago	4.12½	4.125	4.50

COKE—The following are prices per net ton at ovens, Connellsville:

	Jan. 2	Dec. 9	Dec. 2
Prompt furnace	$6.00	$6.00	$6.50
Prompt foundry	7.00	7.00	7.00

FIRE CLAY—The following prices prevail:

		Current
Ottawa, bulk in carloads	Per Ton	$8.00
Cleveland	375-lb. bag	2.50

LINSEED OIL—These prices are per gallon:

	New York		Chicago	
	Current	One Year Ago	Current	One Year Ago
Raw in barrels (5 bbl. lots)	$1.90	$1.59	$1.77	$1.90
5-gal. cans	2.10	1.84	1.97	2.00

WHITE AND RED LEAD—Base price per pound:

	Red				White			
	Current		One Year Ago		Current		One Year Ago	
	Dry	In Oil	Dry	In Oil	Dry and In Oil		Dry and In Oil	
100 lb. keg	14.50	15.50	14.00	15.50	14.50		14.00	
25 and 50-lb. kegs	14.75	15.75	14.25	15.75	14.75		14.25	
12½-lb. keg	15.00	16.00	14.50	16.00	15.00		14.50	
5-lb. cans		17.50	.....	.....	16.50		16.00	
1-lb. cans		18.50	.....	.....	17.50		17.00	

500 lb. lots less 10% discount. 2000 lb. lots less 10-2½% discout

Metal Working

NEW ENGLAND STATES

Conn., Bridgeport—A. F. Crotty, 385 William St., has awarded the contract for the construcion of a 1 story, 60 x 101 ft. garage. Estimated cost, $25,000.

Conn., Hartford—F. C. Walz, Archt., 348 Trumbull St., will soon award the contract for the construction of a 2 story garage for J. Frary, 465 Albany Ave. Estimated cost, $30,000.

Conn., Meridan—The Aeolian Co., Tremont St., manufacturer of musical instruments has awarded the contract for the construction of a 4 story, 50 x 104 ft. and a 1½ story, 42 x 60 ft. factory.

Conn., New Haven—H. and T. McCheskey Sons, Inc., manufacturer of Foordrinier wires, has awarded the contract for the construction of a 1 story, 45 x 100 ft. factory, on Grand Ave. Estimated cost, $25,000.

Conn., New Haven—The W. Schollhorn Co., Wallace St., manufacturer of tools, has awarded the contract for the construction of a 4 story, 40 x 130 ft. factory, on Chapel and Wallace Sts. Estimated cost, $84,000.

Conn., Stamford — J. C. O'Connor, 215 West Broad St., will build a 1 story, 50 x 130 ft. addition to its garage, on Main St. Estimated cost, $21,000.

Conn., Waterbury—The Amer. Pin Co., Waterville, has awarded the contract for the construction of a 4 story, 50 x 204 ft. factory. Estimated cost, $200,000.

Conn., Westport—J. Levy, State St., plans to build a 1 story garage. Estimated cost, $25,000.

Mass., Brookline (Boston P. O.)—L. Shapiro, 27 School St., will build a 2 story, 85 x 270 ft. automobile sales and service station, on Commonwealth Ave. Estimated cost, $25,000.

Mass., Cambridge—The Eco Mfg. Co., 941 Exchange St., will soon award the contract for the construction of a 2 story, 50 x 170 ft. factory, on Charles River Parkway, for the manufacture of machinery. Estimated cost, $65,000. Densmore & McClear, 88 Broad St., Boston, Archt.

Mass., Charlestown (Boston P. O.)—The Commercial Brewing Co., Rollins St., has awarded the contract for the construction of a 2 story, 70 x 182 ft. garage, on Cambridge St. Estimated cost, $100,000.

Mass., Charlestown (Boston P. O.)—L. E. Page, 505 Rutherford Ave., plans to build a 1 story addition to his garage, on Mill St. Estimated cost, $30,000.

Mass., Everett (Boston P. O.)—The Cameron Appliance Co., 48 Waters Ave., has had plans prepared by McNaughton & Robinson, Archts., 101 Tremont St., Boston, for the construction of a 1 story, 40 x 180 ft. factory, for the manufacture of electrical appliances. Estimated cost, $30,000.

Mass., Newton (Boston P. O.)—M. N. Bray Estate, Berlin St., Wollaston, is having plans prepared by Kendall, Taylor & Co., Archts., 93 Federal St., Boston, for the construction of a 1 story addition to its garage. Estimated cost, $25,000.

Mass., Newton (Boston P. O.)—The H. W. Orr Co., 869 Washington St., Newtonville, has awarded the contract for the construction of a 1 story, 80 x 82 ft. garage, on Washington St., here. Estimated cost, $25,000.

Mass., Norfolk Downs (Boston P. O.)—The Pneumatic Scales Co. has awarded the contract for the construction of a 3 story, 150 x 160 ft. factory.

Mass., Roslindale (Boston P. O.)—R. McPherson, c/o J. Murray, Archt., 101 Tremont St., Boston, is having plans prepared for the construction of a garage on Robert St.

Mass., Willimansett — B. F. Perkins & Son, Inc., 2 Crescent St., Holyoke, (machinists), has awarded the contract for the construction of a 1 story, 25 x 120 ft. factory. Estimated cost beween $20,000 and $25,000.

R. I., Providence—J. Avilla, c/o R. J. Vehicle Co., 404 Wickendon St., is having plans prepared by Marshak & Hickey, Archts., 310 Strand Bldg., for the construction of a 1 and 2 story, 50 x 100 ft. garage, on Wickendon St. Estimated cost, $25,000.

R. I., Providence—The Co-operative Club Garage Co., Power St., has awarded the contract for the construction of a 1 story, 50 x 100 ft. garage, on Power and Thayer Sts. Estimated cost, $25,000.

R. I., Providence—E. A. and E. G. Gage, c/o Page & Page, Archts., 87 Weybosset St., have awarded the contract for the construction of a 1 and 2 story, 83 x 95 ft. garage, on Fountain St. Estimated cost, $25,000.

MIDDLE ATLANTIC STATES

N. J., Hilton—H. Boker & Co., Inc., 101 Duane St., New York City, manufacturer of steel hardware and cutlery, will soon award the contract for the construction of a 3 story, 135 x 135 ft. factory, a 1 story, 75 x 135 ft. shop and a 1 story, 50 x 80 ft. power house. G. C. Higby, 207 Market St., Newark, Archt.

N. J., Trenton—The Mercer Motors Co., Whitehead Rd., plans to improve and enlarge its plant here. Estimated cost, $650,000. E. S. Hare, 245 West 55th St., New York City, Pres.

N. Y., New York (Borough of Bronx)—The Eckman Building Co., 1174 Bryant Ave., will build a 1 story, 120 x 125 ft. garage on 156th St. and Hegney Ave. Estimated cost $75,000.

N. Y., New York (Borough of Brooklyn)—Havemeyer & Elder, 177 Montague St., will build a 1 story, 100 x 150 ft. garage on Nostrand and DeKalb Aves. Estimated cost, $60,000.

N. Y., New York (Borough of Brooklyn)—The Interboro Iron and Steel Co., 41 Park Row, New York City, will build a 1 story, 100 x 200 ft. garage on Sullivan and Bedford Aves. Estimated cost, $150,000, a 1 story 100 x 120 ft. garage on Malbone St. and Bedford Ave., $65,000 and a 1 story, 150 x 200 ft. garage on Sullivan and Bedford Aves., $150,000.

N. Y., New York (Borough of Brooklyn)—A. Milea, 139 Union St., will build a 1 story, 75 x 95 ft. garage at 363 Columbus St. Estimated cost, $25,000.

N. Y., New York (Borough of Brooklyn)—Pirozzi Sons, Inc., 2064 Pacific St., will build a 1 story, 100 x 160 ft. garage on 4th Ave. and 7th St. Estimated cost, $50,000.

N. Y., New York (Borough of Manhattan)—M. J. Gordan, 459 9th Ave., will build a 2 story, 50 x 100 ft. garage at 429-431 West 36th St. Estimated cost, $25,000.

N. Y., New York (Borough of Manhattan)—H. C. Griffin & Co., 143 Varick St., has awarded the contract for the construction of a 3 story, 50 x 200 ft. factory at 61 Vandam St., for the manufacture of millwrights. Estimated cost, $90,000.

N. Y., New York (Borough of Manhattan)—The 145th St. Theatre Corp., 120 Broadway, is having plans prepared by I. W. Lamb, Archt., 644 8th Ave., for the construction of a 2 story, 88 x 172 ft. garage and theatre, at 246-262 West 145th St. Estimated cost, $300,000.

N. Y., New York (Borough of Queens)—J. J. Daly, c/o J. H. Baker, Archt., 9 Jackson Ave., Long Island City, is having plans prepared for the construction of a 1 story, 100 x 100 ft. garage, on Mott and Harris Aves. Estimated cost, $25,000.

N. Y., Rochester—The Josiah Anstice Co., Inc., manufacturer of hardware specialties and gray iron castings, plans to build a 1 story, 145 x 216 ft. foundry, on Humboldt St. Estimated cost, $85,000.

Penn., Altoona — The Altoona Overland Co., 900 Green Ave., plans to build a 4 story, 50 x 133 ft. garage and salesroom, at 814 Chestnut Ave. Estimated cost, $50,000.

Penn., Chester—W. F. Gray, 502 West 7th St., will soon award the contract for the construction of a 2 story, 50 x 117 ft. garage, on 7th and Parker Sts. Estimated cost, $20,000. W. F. Smith, Broad and Arch St., Philadelphia, Archt.

Penn., Philadelphia — The Enterprise Mfg. Co., 3rd and Dauphin Sts., has awarded the contract for the construction of a 3 story, 100 x 100 ft. factory, for the manufacture of hardware.

Penn., Philadelphia — The Gomery-Schwartz Motor Car Co., 128 North Broad St., has awarded the contract for the construction of a 6 story, 220 x 440 ft. sales and service station, on 24th and Market Sts. Estimated cost, $700,000.

Penn., Philadelphia—A. Kerr Bros. & Co., Delaware and Green Sts. has awarded the contract for the construction of a 2 story, 62 x 125 ft. garage, on Race and 22nd Sts. Estimated cost, $25,000.

Penn., Philadelphia — The Philadelphia Storage Battery Co., Ontario St., has awarded the contract for the construction of a 3 story, 26 x 50 ft. and 50 x 220 ft. addition to its plant. Estimated cost, $50,000.

SOUTHERN STATES

Tenn. Chattanooga — The Sommerville Iron Wks. has awarded the contract for the construction of a 1 story foundry and machine shop. Estimated cost, $100,000.

MIDDLE WEST

Ill., Chicago—The Stromberg Motor Devices Co., 68 East 25th St., has awarded the contract for the construction of a 6 story, 75 x 130 ft. factory, on Wabash St. Estimated cost, $300,000.

Ind., Indianapolis—The Cole Motor Car Co., 750 East Washington St., has awarded the contract for the construction of a 4 story, 179 x 225 ft. automobile assembly plant, on Market and Davidson Sts. Estimated cost, $300,000.

Ind., Indianapolis—F. G. Groth, Toledo, Ohio, c/o McMeans & Tripp, Archts., Majestic Bldg., Indianapolis, has awarded the contract for the construction of a 2 story factory on St. Paul St. and Cleveland, Cincinnati, Chicago & St. Louis Ry., for the St., Detroit, plans to build a 1 and 2 story, ft. factory. Estimated cost, $80,000.

Mich., Detroit — The Clayton Lambert Mfg. Co., Beaubien St., plans to build a 1 and 2 story factory, along the Detroit Terminal Ry. Estimated cost, $500,000.

Mich., Detroit—The Columbia Motor Car Co., 1256 East Jefferson Ave., is having plans prepared by H. H. Lane, Engr., Dime Bank Bldg., for the construction of a 2 and 3 story, 300 x 720 ft. factory on Fort and Boyd Sts., for the manufacture of automobile parts. Estimated cost, $600,000.

Mich., Detroit—The Detroit Steel Products Co., West Grand Blvd., has awarded the contract for the construction of a 1 story, 106 x 313 ft. steel shed and spring shop. Estimated cost, $80,000.

Mich., Marysville—The General Aluminum and Brass Co., Boulevard and St. Aubin St., Detroit, plans to build a 1 and 2 story, foundry on Cuttle Rd., here. Estimated cost, $75,000.

Mich., Redford — The Michigan State Automobile School, Woodward Ave., Detroit, has had plans prepared by C. W. Brandt, Archt., Kresge Bldg., Detroit, for the construction of a 2 story, 130 x 160 ft. administration building, two, 2 story, 100 x 400 ft. dormitories, a 2 story, 70 x 200 ft. commercial building, a 2 story, 100 x 150 ft. dining hall, a 1 story, 100 x 200 ft. tractor building, a 1 story, 40 x 300 ft. motor building, a 2 story, 90 x 300 ft. garage and a 1 story, 80 x 150 ft. pumping station and power plant. Estimated cost, $2,000,000.

O., Cincinnati — The G. Gruen Watch Co., Time Hill, has awarded the contract for the construction of a 5 story, 60 x 80 ft. factory. Estimated cost, $80,000.

O., Cleveland—The Cleveland Folding Machine Co., 5200 Euclid Ave., has awarded the contract for the construction of a 1 story, 80 x 129 ft. factory, at 1830 East 63rd St. Estimated cost, $40,000. E. H. Jones, Mgr.

O., Cleveland—The Dill Manufacturing Co., 686 East 82nd St., metal stampers, has awarded the contract for the construction of a 1 story, 73 x 245 ft. factory, at 686 East 82nd St. Estimated cost, $60,000.

O., Cleveland — The Ohio Body and Blower Co., 9301 Detroit Ave., has awarded the contract for the construction of a 1 story, 100 x 300 ft. factory. Estimated cost, $100,000.

O., Cleveland—The Standard Wire and Spring Co., 5915 Bonna Ave., will soon award the contract for the construction of a 1 story, 101 x 165 ft. factory, on 39th St. and Superior Ave. Estimated cost, $75,000. A. A. Bartlett, Mgr. Lehman & Schmitt, Electric Bldg. Archts.

O., Columbus—The Austin Western Road Mchy. Co., 910 South Michigan Ave., Chicago, plans to build a branch factory and assembling plant, here.

O., Springfield — The Kelly Springfield Motor Truck Co., Bart St., plans to build a 1 story 60 x 80 ft. and a 2 story, 65 x 100 ft. machine shop, also a 3 story, 50 x 80 ft. factory and office, on Sheridan and Bart St. Estimated cost, $100,000.

O., Toledo—N. Rassel Sons Co., Grandolph and La Grange Sts., manufacturer of fertilizers, has awarded the contract for the construction of a 2 story, 22 x 55 x 88 ft. factory. Estimated cost, $15,000.

Wis. Sheboygan—The Porcelain Enameling Co., c/o W. J. Vollrath, 821 North 6th St., plans to build a 4 story, 60 x 150 ft. factory, on Lake Shore Rd. Estimated cost, $20,000.

Wis., West Allis—The Avery Co., 57th Ave. and Mitchell St., has awarded the contract for the construction of a 1 story, 42 x 200 ft. addition to its machine shop. Estimated cost, $50,000.

WEST OF MISSISSIPPI STATES

Kan., Atchison — The Cooper Foundry Co. has awarded the contract for the construction of a 1 story, 120 x 350 ft. foundry. Estimated cost, $50,000.

Minn., Minneapolis—The Harris Realty Co., New England Bldg., Marquette Ave., has awarded the contract for the construction of a 2 story, 100 x 120 ft. garage, on Lincoln and Aldrich Ave., S. Estimated cost, $52,000.

Mo., St. Louis—The Wagner Electric Co., 6400 Plymouth St., will soon award the contract for the construction of a 6 story, 60 x 60 ft. and 60 x 400 ft. magneto factory. Estimated cost, $550,000.

S. D., Ipswich—Bd. Educ. is having plans prepared by Erwins & Erwins, Engrs., 911 Northwestern Bank Bldg., Minneapolis, Minn., for the construction of a 2 story, 75 x 120 ft. grade and high school, to consist of an auditorium, a gymnasium, domestic science room and a manual training hall. Estimated cost, $100,000. J. Owens, Clk.

CANADA

Ont., Owen Sound—Bd. Educ. plans to build a 3 story technical school, to consist of 16 rooms and a manual training department. Estimated cost, $180,000.

Ont., Braeside—Gillies Bros., Arnprior, has awarded the contract for the construction of a 2 story, 73 x 190 ft. sawmill and box factory, here. Estimated cost, $100,000.

Ont., Woodstock—The De Long Hook and Eye Co., 41 Finkle St., plans to remodel a 3 story building and use same for its own use.

General Manufacturing

NEW ENGLAND STATES

Conn., Bridgeport—The Amer. Specialty Co., 348 George St., plans to build a 3 story, 40 x 140 ft. factory on Holland Ave., for the manufacture of novelties. Estimated cost, $40,000.

Conn., Hartford—The Goodyear Tire and Rubber Co., High St., is having plans prepared by Berenson & Moses, Archts., Pilgard Bldg., for the construction of a 4 story, 70 x 160 ft. factory, office and storage building, on Winthrop St. Estimated cost, $300,000.

Mass., East Boston (Boston P. O.)—The Boston & Lockport Block Co., 100 Coudor St., has awarded the contract for the construction of a 2 story, 80 x 245 ft. factory. Estimated cost, $100,000.

Mass., Haverhill—The Whittier Bldgs., Inc., First Natl. Bank Bldg., plans to construct a factory on Washington St., for the manufacture of shoes. Estimated cost, $700,000.

Mass., South Boston—The Package Confectionery Co., 741 East 6th St., is having plans prepared by Putnam & Cox, Archts., 114 State St., Boston, for the construction of a 3 story 45 x 100 ft. factory. Estimated cost, $40,000.

Mass., West Rutland — The Naguog Worsted Mills plan to build a 1 story factory.

R. I., Bellefont—The Imperial Printing & Finishing Co. has awarded the contract for the construction of a 1 story, 50 x 100 ft. and 70 x 200 ft. addition to its dye and finishing mill. Estimated cost, $65,000.

R. I., Esmond—The Esmond Mills has awarded the contract for the construction of a 108 x 110 ft. and 100 x 125 ft. additions to its blanket mill. Estimated cost, $125,000.

R. I., Peacedale—The Peacedale Mfg. Co. will build a 2 story, 54 x 80 ft. addition to its worsted mill. Estimated cost, $35,000.

R. I., Providence—The L. Vaughn Co., 1153 Westminister St., has awarded the contract for the construction of a 3 story, 35 x 100 ft. woodworking factory.

R. I., South Kingstown (Kingstown P. O.)—The Peacedale Manufacturing Co. will build two, 2 story, 55 x 80 ft. factories, for the manufacture of worsted goods. Estimated cost, $30,000.

MIDDLE ATLANTIC STATES

N. J., Asbury Park—The Rydon Tire and Rubber Co., c/o E. A. Arend, Archt. and Engr., 105 West 40th St., Manhattan, has awarded the contract for the construction of a factory. Estimated cost, $100,000.

N. J., Hoboken—The Amer. Lead Pencil Co., Willow Ave., has awarded the contract for the construction of a 1 story, 60 x 200 ft. addition to its factory. Estimated cost, $50,000.

N. J., Jersey City—The Pencil Exchange, 67 and 69 Fleet St., plans to build a 3 story, 48 x 69 ft. factory. Estimated cost, $29,315.

N. J., Newark—Blanchard & Co., c/o W. Lehman, Archt., 738 Broad St., manufacturer of carriage leather, has awarded the contract for the construction of a 2 story, 50 x 97 ft. factory, on Sussex Ave. Estimated cost, $50,000.

N. Y., New York, (Borough of Brooklyn)—H. H. Hessner & Son, 33 Bartlet St., manufacturer of wheelwrights, etc., will build a 1 story, 100 x 200 ft. factory. Estimated cost, $65,000.

N. Y., New York (Borough of Queens)—C. E. Sheppard, 311 Hudson St., New York City, manufacturer of loose leaf devices, has awarded the contract for the construction of a 3 story factory on Van Alst Ave., Long Island City. Estimated cost, $250,000.

SOUTHERN STATES

Va., Petersburg—The Steward Trunk and Bag Co. has had plans prepared by F. A. Bishop, Archt., Petersburg, for the construction of a 2 story, 30 x 84 ft. factory, on High St. Estimated cost, $25,000.

MIDDLE WEST

Ill., Chicago—The Channel Chemical Co., 58 East Washington St., manufacturer of O'Cedar mops and floor oils, has awarded the contract for the construction of a 4 story, 150 x 300 ft. factory, on Western Ave. and West 45th St. Estimated cost, $450,000. Noted Jan. 16.

Ill., Chicago — The Illinois Glass Co., Alton, has purchased a large site on North Crawford Ave., here, and plans to build a plant. Estimated cost, $250,000.

Mich., Detroit—The General Carbonic Co., 542 5th Ave., New York City, has awarded the contract for the construction of a 1 story, 100 x 120 ft. manufacturing plant, 40 x 50 ft. boiler house and a 25 x 30 ft. garage, all 1 story. Total estimated cost, $75,000.

O., Akron—The Amer. Tire and Rubber Co., Beech St., plans to build a 4 story factory, for the manufacture of tires.

O., Cleveland—The Acorn Refining Co., 8001 Franklin Ave., will soon award the contract for the construction of a 4 story, 40 x 105 ft. factory. Estimated cost, $60,000.

O., Cleveland—The National Builders Co., 1187 West 11th St., will soon award the contract for the construction of a 2 story, 54 x 612 ft. factory, on Park Ave., for the manufacture of building materials. Estimated cost, $60,00.

Wis., Greenwood—Blum Bros. plan to build a 3 story, 60 x 200 ft. cheese box factory on Main St. Estimated cost, $50,000.

Wis., Jefferson—The Jefferson Creamery Co. has purchased a site on Main St., and plans to build a 2 story, 60 x 120 ft. creamery and cheese factory. Estimated cost, $50,000.

Wis., Manitowoc—A. H. Franke Co., 627 South River St., manufacturer of pocket cases, has awarded the contract for the construction of a 2 story, 30 x 160 ft. factory, on 12th St. Estimated cost, $30,000.

Wis., Milwaukee—The Federal Textile Co., 1306 First Wisconsin National Bank Bldg., plans to build a 1 and 2 story textile plant on Burleigh St.

Wis., Milwaukee—The Ludwig-Wolf Ice Cream Co., 608 Caswell Blk., has awarded the contract for the construction of a 2 story, 40 x 52 ft. factory, on 12th and Clarke St. Estimated cost, $25,000.

Wis., Milwaukee—The Pfister Vogel Leather Co., 443 Virginia St., has awarded the contract for the construction of a 1 story, 150 x 300 ft. tannery, on 2nd Ave. and Virginia St. Estimated cost, $125,000.

WEST OF THE MISSISSIPPI

Minn., Minneapolis — The Northwestern Glass Co., 219 2nd St., N., has had plans prepared by Bertrand & Chamberlain, Archts., Northwestern Bank Bldg., for the construction of a 4 story, 66 x 162 ft. addition to its factory. Estimated cost, $100,000.

Neb., Lincoln — The Gooch Milling and Elevator Co., 6th and South Sts., is having plans prepared by The Sherman Engineering Co., Engrs., 1019 New York Life Bldg., Kansas City, Mo., for the construction of a 70 x 90 ft. flour mill. Estimated cost, $250,000.

Utah, Salt Lake City—The Salt Lake Stamp Co., 65 West Broadway, will soon award the contract for the construction of a 2 story, 35 x 110 ft. factory. Estimated cost, $50,000.

Wash., Spokane—The Centennial Mills, 817 Howard St., are having plans prepared by A. E. Witherspoon, Arch., for the construction of an 8 story flour mill. Estimated cost, $1,000,000.

Wash., Spokane—The Porcupine Boot Mfg. Co. is having plans prepared by F. S. Campbell, Pres. of The Auto Boot Manufacturing Co., Spokane, for the construction of a 2 or 3 story factory, for the manufacture of inner tube patches. Estimated cost, $10,000.

WESTERN STATES

Cal., Los Angeles—The Los Angeles Soap Co., 633 East 1st St., is having plans prepared by Morgan Walls & Morgan, Archts., 1124 Van Nuys Bldg., for the construction of a 1 story, 40 x 80 ft. boiler house, a 30 x 40 ft. distillery building, 80 ft. high and a 30 x 40 ft. machine shop.

Cal., Santa Paula—The California Prune and Apricot Growers Association, Market and San Antonio Sts., San Jose, plans to build a packing house and jam factory, here.

Cal., Vesalia—The California Prune and Apricot Growers Association, Market and San Antonio Sts., San Jose, plans to build a packing house here. Estimated cost, $100,000.

Ore., Salem—The Puyallup & Sumner Co. plans to build a 2 story fruit cannery. Estimated cost, $60,000.

Wash., Sedro Woolley—F. Jungmeyer has awarded the contract for the construction of a 40 x 90 ft. garage. Estimated cost, $50,000.

CANADA

Ont., Toronto—The Prest-O-Lite Co., Inc., 120 Elm St., has awarded the contract for the construction of a 3 story factory, on Hillcrest Race Course. Estimated cost, $400,000.

Ont., Toronto—Willard Chocolates, Ltd., 443 Wellington St., has awarded the contract for the construction of a 5 story, 80 x 150 ft. factory, on Dupont St. and Manning Ave. Estimated cost, $150,000.

Que., St. Jerome—The Regent Knitting Co., Ltd., Duluth and St. Lawrence St., Montreal, will soon award the contract for the construction of a 2 story, 50 x 75 ft. factory, on Notre Dame St. Estimated cost, $85,000.

Machine Tools Wanted

The following concerns are in the market for machinery and machine tools:

N. Y., Buffalo—The Darz Mchy. Co., 66 Exchange Pl. — horizontal and vertical boring mills (used.)

Penn., Philadelphia—The Newton Machine and Tool Wks., Inc., 23rd and Vine Sts.—machine shop equipment.

Penn., Philadelphia—The Wicaco Machine Screw Co., 7th and Wood St.—machine shop equipment.

Ill., Chicago—The Continental Can Co., 4645 Grand Ave. — surface grinder with range 26 in. x 15 in.

Ind., Aurora—The Langhaar Ball Bearing Co.—rotary surface grinder.

Mich., Detroit—The Detroit Steel Products Co., West Grand Blvd.,—65 ft. span traveling crane.

Mich., Marysville—The General Aluminum and Brass Co., Boulevard and St. Aubin St., Detroit—cupolas, tumblers, conveyors and travelet.

O., Cleveland—The Standard Wire and Spring Co., 5915 Bonna Ave.—3 special wire spring making machines.

O., Fremont—The National Razor Mfg. Co.—400 lb. automatic drop hammer.

O., Van Wert—The Advance Mchy. Co. —42 x 42 in. x 10 ft. planer, 36 x 36 x 8 ft. to 10 ft. planer; 4 to 6 ft. radial drill, with gear box drive, (preferably used.)

Wis., Milwaukee—The Precision Machine Co., 603 Toy Bldg. —13 in. lathe, 5 ft. bed, a milling machine, 20 in. drill presses and a bobbing machine for small gears.

Ont., Braeside—Gillies Bros., Arnprior—motors and band saws, also wood working machines for box manufacturer.

Ont., Owen Sound—Bd. Educ.—mahual training and technical laboratory machinery.

Ont., Toronto—W. D. Beath & Son, Ltd., Cooper Ave.—a 150 to 250 ton power press, 36-48 in. between uprights.

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